INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

(Approved by AICTE | NAAC Accreditation with 'A' Grade | Accredited by NBA | Affiliated to JNTUH)

Dundigal, Hyderabad - 500 043, Telangana

OUTCOME BASED EDUCATION
WITH
CHOICE BASED CREDIT SYSTEM

MASTER OF TECHNOLOGY
AEROSPACE ENGINEERING

ACADEMIC REGULATIONS, COURSE STRUCTURE AND SYLLABI
(Based on AICTE Model Curriculum)

IARE - R18

M.Tech Regular Two Year Degree Program
(for the batches admitted from the academic year 2018 - 2019)

FAILURE TO READ AND UNDERSTAND THE REGULATIONS IS NOT AN EXCUSE

INSTITUTE VISION | MISSION | QUALITY POLICY

VISION

To bring forth professionally competent and socially sensitive engineers, capable of working across cultures meeting the global standards ethically.

MISSION

To provide students with an extensive and exceptional education that prepares them to excel in their profession, guided by dynamic intellectual community and be able to face the technically complex world with creative leadership qualities.

Further, be instrumental in emanating new knowledge through innovative research that emboldens entrepreneurship and economic development for the benefit of wide spread community.

QUALITY POLICY

Our policy is to nurture and build diligent and dedicated community of engineers providing a professional and unprejudiced environment, thus justifying the purpose of teaching and satisfying the stake holders.

A team of well qualified and experienced professionals ensure quality education with its practical application in all areas of the Institute.

DEPARTMENT VISION | MISSION

VISION

To build a strong community of dedicated graduates with expertise in the field of aeronautical science and engineering suitable for industrial needs having a sense of responsibility, ethics and ready to participate in aerospace activities of national and global interest.

MISSION

To actively participate in the technological, economic and social development of the nation through academic and professional contributions to aerospace and aviation areas, fostering academic excellence and scholarly learning among students of aeronautical engineering.

M.TECH (AEROSPACE ENGINEERING) - PROGRAM EDUCATIONAL OBJECTIVES (PEO's)

The students of M.Tech Aerospace Engineering are prepared to:

PEO - I	Obtain employment in industry, government institutions, small businesses, or organizations successfully using the skills they acquired in aerospace engineering and related fields.
PEO - II	Pursue Doctoral degree and to conduct research at various Universities/Institutions.
PEO - III	Apply their in-depth knowledge in Computational Mechanics / Fluid Dynamics to evaluate, analyze and synthesize existing and novel designs of aerospace components and systems.
PEO - IV	Contribute to the advancement of aerospace engineering, science or related fields through new discoveries, solving problems, program management or by educating/mentoring others.

M.TECH - PROGRAM OUTCOMES (PO's)

Upon completion of M.Tech Degree, the students will be able to:

PO - 1	Independently carry out research/investigation and development work to solve practical problems.
PO - 2	Write and present a substantial technical report/document
PO - 3	Demonstrate a degree of mastery in emerging areas of Aerospace Engineering such as Aerodynamics, Propulsion, Structure and Flight Dynamics
PO - 4	Identify, formulate, analyse and Design complex engineering problems, and design system components or processes by applying appropriate advanced principles of engineering activities and using modern tools
PO - 5	Engage in life-long learning and professional development through self-study and continuing education in understanding the engineering solutions in global and management principles to manage projects in multidisciplinary environments.
PO - 6	Function effectively as a member or leader in diverse teams to carry out development work, produce solutions that meet the specified needs with frontier technologies and communicate effectively on complex engineering activities.

CONTENTS

"Take up one idea.
Make that one idea you're life-think of it, dream of it, and live on that idea. Let the brain muscles, nerves, every part of your body be full of that idea and just leave every other idea alone.
This is the way to success" Swami Vivekananda

PRELIMINARY DEFINITIONS AND NOMENCLATURES

Academic Council: The Academic Council is the highest academic body of the institute and is responsible for the maintenance of standards of instruction, education and examination within the institute. Academic Council is an authority as per UGC regulations and it has the right to take decisions on all academic matters including academic research.

Academic Autonomy: Means freedom to an institute in all aspects of conducting its academic programs, granted by UGC for Promoting Excellence.

Academic Year: It is the period necessary to complete an actual course of study within a year. It comprises two consecutive semesters i.e., Even and Odd semester.

AICTE: Means All India Council for Technical Education, New Delhi.

Autonomous Institute: Means an institute designated as autonomous by University Grants Commission (UGC), New Delhi in concurrence with affiliating University (Jawaharlal Nehru Technological University, Hyderabad) and State Government.

Backlog Course: A course is considered to be a backlog course if the student has obtained a failure grade (F) in that course.

Basic Sciences: The courses offered in the areas of Mathematics, Physics, Chemistry, Biology etc., are considered to be foundational in nature.

Betterment: Betterment is a way that contributes towards improvement of the students' grade in any course(s). It can be done by either (a) re-appearing or (b) re-registering for the course.

Board of Studies (BOS): BOS is an authority as defined in UGC regulations, constituted by Head of the Organization for each of the departments separately. They are responsible for curriculum design and updation in respect of all the programs offered by a department.

Certificate course: It is a course that makes a student gain hands-on experience and skill required for holistic development in a specific area/field.

Choice Based Credit System: The credit based semester system is one which provides flexibility in designing curriculum and assigning credits based on the course content and hours of teaching along with provision of choice for the student in the course selection.

Compulsory course: Course required to be undertaken for the award of the degree as per the program.

Commission: Means University Grants Commission (UGC), New Delhi.

Continuous Internal Examination: It is an examination conducted towards internal assessment.

Course: A course is a subject offered by the University for learning in a particular semester.

Course Outcomes: The essential skills that need to be acquired by every student through a course.

Credit: A credit is a unit that gives weight to the value, level or time requirements of an academic course. The number of 'Contact Hours' in a week of a particular course determines its credit value. One credit is equivalent to one lecture hour per week.

Credit point: It is the product of grade point and number of credits for a course.

Cumulative Grade Point Average (CGPA): It is a measure of cumulative performance of a student over all the completed semesters. The CGPA is the ratio of total credit points secured by a student in various courses in all semesters and the sum of the total credits of all courses in all the semesters. It is expressed upto two decimal places.

Curriculum: Curriculum incorporates the planned interaction of students with instructional content, materials, resources and processes for evaluating the attainment of Program Educational Objectives.

Degree with Specialization: A student who fulfills all the program requirements of her/his discipline and successfully completes a specified set of professional elective courses in a specialized area is eligible to receive a degree with specialization like Structural Engineering, Embedded Systems, CSE, etc.

Department: An academic entity that conducts relevant curricular and co-curricular activities, involving both teaching and non-teaching staff and other resources in the process of study for a degree.

Detention in a course: Student who does not obtain minimum prescribed attendance in a course shall be detained in that particular course.

Dropping from the Semester: A student who doesn't want to register for any semester can apply in writing in prescribed format before commencement of that semester.

Elective Course: A course that can be chosen from a set of courses. An elective can be Professional Elective and/or Open Elective.

Evaluation: Evaluation is the process of judging the academic performance of the student in her/his courses. It is done through a combination of continuous internal assessment and semester end examinations.

Grade: It is an index of the performance of the students in a said course. Grades are indicated by alphabets.

Grade Point: It is a numerical weight allotted to each letter grade on a 10 point scale.

Institute: Means Institute of Aeronautical Engineering, Hyderabad unless indicated otherwise by the context.

Massive Open Online Course (MOOC): MOOC courses inculcate the habit of self learning. MOOC courses would be additional choices in all the elective group courses.

Pre-requisite: A course, the knowledge of which is required for registration into higher level course.

Core: The courses that are essential constituents of each engineering discipline are categorized as professional core courses for that discipline.

Professional Elective: A course that is discipline centric. An appropriate choice of minimum number of such electives as specified in the program will lead to a degree with specialization.

Program: Means, Master of Technology (M.Tech) degree program / UG degree program: B.Tech.

Program Educational Objectives: The broad career, professional and personal goals that every student will achieve through a strategic and sequential action plan.

Project work: It is a design or research based work to be taken up by a student during his/her second year to achieve a particular aim. It is a credit based course and is to be planned carefully by the student.

Re-Appearing: A student can reappear only in the semester end examination for the theory component of a course, subject to the regulations contained herein.

Registration: Process of enrolling into a set of courses in a semester of a Program.

Regulations: The regulations, common to all M.Tech programs offered by Institute are designated as "IARE-R18" and are binding on all the stakeholders.

Semester: It is a period of study consisting of 15 to 18 weeks of academic work equivalent to normally 90 working days. The odd semester starts usually in July and even semester in December.

Semester End Examinations: It is an examination conducted for all courses offered in a semester at the end of the semester.

S/he: Means "she" and "he" both.

Student Outcomes: The essential skill sets that need to be acquired by every student during her/his program of study. These skill sets are in the areas of employability, entrepreneurial, social and behavioral.

University: Means the Jawaharlal Nehru Technological University Hyderabad, Hyderabad.

Withdraw from a Course: Withdrawing from a course means that a student can drop from a course within the first two weeks of the odd or even semester (deadlines are different for summer sessions). However s/he can choose a substitute course in place of it by exercising the option within 5 working days from the date of withdrawal.

Words 'he', him', 'his', occur, they imply 'she', 'her', 'hers' also.

FOREWORD

The autonomy is conferred to Institute of Aeronautical Engineering (IARE), Hyderabad by University Grants Commission (UGC), New Delhi based on its performance as well as future commitment and competency to impart quality education. It is a mark of its ability to function independently in accordance with the set norms of the monitoring bodies like J N T University Hyderabad (JNTUH), Hyderabad and AICTE. It reflects the confidence of the affiliating University in the autonomous institution to uphold and maintain standards it expects to deliver on its own behalf and thus awards degrees on behalf of the college. Thus, an autonomous institution is given the freedom to have its own **curriculum, examination system and monitoring mechanism**, independent of the affiliating University but under its observance.

IARE is proud to win the credence of all the above bodies monitoring the quality in education and has gladly accepted the responsibility of sustaining, if not improving upon the standards and ethics for which it has been striving for more than a decade in reaching its present standing in the arena of contemporary technical education. As a follow up, statutory bodies like Academic Council and Boards of Studies are constituted with the guidance of the Governing Body of the institute and recommendations of the JNTUH to frame the regulations, course structure and syllabi under autonomous status.

The autonomous regulations, course structure and syllabi have been prepared after prolonged and detailed interaction with several expertise solicited from academics, industry and research, in accordance with the vision and mission of the institute to order to produce a quality engineering graduate to the society.

All the faculty, parents and students are requested to go through all the rules and regulations carefully. Any clarifications needed are to be sought at appropriate time and with principal of the college, without presumptions, to avoid unwanted subsequent inconveniences and embarrassments. The Cooperation of all the stake holders is sought for the successful implementation of the autonomous system in the larger interests of the college and brighter prospects of engineering graduates.

PRINCIPAL

INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

ACADEMIC REGULATIONS

M.Tech. Regular Two Year Degree Program
(for the batches admitted from the academic year 2018 - 20)

For pursuing two year postgraduate Master Degree program of study in Engineering (M.Tech) offered by Institute of Aeronautical Engineering under Autonomous status and herein after referred to as IARE.

1.0 CHOICE BASED CREDIT SYSTEM

The Indian Higher Education Institutions (HEI's) are changing from the conventional course structure to Choice Based Credit System (CBCS) along with introduction to semester system at first year itself. The semester system helps in accelerating the teaching learning process and enables vertical and horizontal mobility in learning.

The credit based semester system provides flexibility in designing curriculum and assigning credits based on the course content and hours of teaching. The choice based credit system provides a 'cafeteria' type approach in which the students can take courses of their choice, learn at their own pace, undergo additional courses and acquire more than the required credits and adopt an interdisciplinary approach to learning.

Choice Based Credit System (CBCS) is a flexible system of learning and provides choice for students to select from the prescribed elective courses. A course defines learning objectives and learning outcomes and comprises of lectures / tutorials / laboratory work / field work / project work /mini project work with seminar/ viva / seminars / presentations / self-study etc. or a combination of some of these.

Under the CBCS, the requirement for awarding a degree is prescribed in terms of number of credits to be completed by the students.

The CBCS permits students to:

1. Choose electives from a wide range of elective courses offered by the departments of the Institute.
2. Undergo additional courses of interest.
3. Adopt an inter-disciplinary approach in learning.
4. Make the best use of expertise of the available faculty.

2.0 MEDIUM OF INSTRUCTION

The medium of instruction shall be English for all courses, examinations, seminar presentations and project work. The curriculum will comprise courses of study as given in course curriculum in accordance with the prescribed syllabi.

3.0 ELIGIBILITY FOR ADMISSION

The admissions for category A and B seats shall be as per the guidelines of Telangana State Council for Higher Education (TSCHE) in consonance with government reservation policy.

a) Under Category A: 70% of the seats are filled based on GATE/PGECET ranks.
b) Under Category B: 30% seats are filled on merit basis as per guidelines of TSCHE.

4.0 UNIQUE COURSE IDENTIFICATION CODE

Every specialization of the M.Tech program will be placed in one of the groups as listed in the Table 1.

Table 1: Group of Courses

S. No	Specialization	Offering Department	Code
1	Structural Engineering	Civil Engineering	ST
2	Electrical Power Systems	Electrical and Electronics Engineering	EPS
3	CAD / CAM	Mechanical Engineering	CC
4	Embedded Systems	Electronics and Communication Engineering	ES
5	Computer Science and Engineering	Computer Science and Engineering	CS
6	Aerospace Engineering	Aeronautical Engineering	AE

5.0 TYPES OF COURSES

Courses in a programme may be of four kinds: **Core, Elective, Open and Audit.**

5.1 Core Course:

There may be a core course in every semester. This is the course which is to be compulsorily studied by a student as a core requirement to complete the requirement of a program in said discipline of study.

5.2 Elective Course:

Electives provide breadth of experience in respective branch and applications areas. Elective course is a course which can be chosen from a pool of courses. It may be:

- Supportive to the discipline of study
- Providing an expanded scope
- Enabling an exposure to some other discipline/domain
- Nurturing student's proficiency/skill.

There shall be five professional core elective groups out of which students can choose not more than two courses from each group. Overall, students can opt for four professional elective courses which suit their project work in consultation with the faculty advisor/mentor. In addition, one course from each of the two open electives has to be selected. A student may also opt for more elective courses in his/her area of interest.

5.3 Open Elective Course:

An elective may be discipline centric focusing on those courses which add generic proficiency to the students or may be chosen from supportive/general discipline called as "Open Elective".

5.4 Audit Course:

The value added courses are audit courses offered through joint ventures with various organizations providing ample Scope for the students as well as faculty to keep pace with the latest technologies pertaining to their chosen fields of study. A plenty of value added programs will be proposed by the departments one week before the commencement of class work. The students are given the option to choose the courses according to their desires and inclinations as they choose the desired items in a cafeteria. The expertise gained through the value added programs should enable them to face the formidable challenges of the future and also assist them in exploring new opportunities. Its result shall be declared with "Satisfactory" or "Not Satisfactory" performance.

6.0 SEMESTER STRUCTURE

The institute shall follow semester pattern. An academic year shall consist of a first semester and a second semester and the summer term. Each semester shall be of 23 weeks (Table 2) duration and this period includes time for course work, examination preparation and conduct of examinations. Each main semester shall have a minimum of 90 working days; out of which number of contact days for teaching / practical shall be 75 and 15 days shall be for examination preparation. The duration for each semester shall be a minimum of 17 weeks of instruction. The Academic Calendar is declared at the beginning of the academic year as given in Table2.

Table 2: Academic Calendar

FIRST SEMESTER (23 weeks)	I Spell Instruction Period	9 weeks	21 weeks
	I Mid Examinations	1 week	
	II Spell Instruction Period	8 weeks	
	II Mid Examinations	1 week	
	Preparation and Practical Examinations	2 weeks	
	Semester End Examinations		2 weeks
Semester Break and Supplementary Exams			2 weeks
SECOND SEMESTER (23 weeks)	I Spell Instruction Period	9 weeks	21 weeks
	I Mid Examinations	1 week	
	II Spell Instruction Period	8 weeks	
	II Mid Examinations	1 Week	
	Preparation & Practical Examinations	2 weeks	
	Semester End Examinations		2 weeks
Summer Vacation and Supplementary Exams			4 weeks
THIRD SEMESTER	I Spell Instruction Period	9 weeks	18 weeks
	I Mid Examinations	1 week	
	II Spell Instruction Period	8 weeks	
	II Mid Examinations	1 week	
	Project Work Phase – I		
	Semester End Examinations		1 week
FOURTH SEMESTER	Project Work Phase - II		18 eeks

7.0 PROGRAM DURATION

A student shall be declared eligible for the award of M.Tech degree, if he/she pursues a course of study and completes it successfully in not less than two academic years and not more than four academic years. A student, who fails to fulfill all the academic requirements for the award of the degree within four academic years from the year of his/her admission, shall forfeit his/her seat in M.Tech course.

a) A student will be eligible for the award of M.Tech degree on securing a minimum of 5.0/10.0 CGPA.
b) In the event of non-completion of project work and/or non-submission of the project report by the end of the fourth semester, the candidate shall re-register by paying the semester fee for the project. In such a case, the candidate will not be permitted to submit the report earlier than three months and not later than six months from the date of registration.

8.0 CURRICULUM AND COURSE STRUCTURE

The curriculum shall comprise Core Courses, Elective Core Courses, Laboratory Course, Mini Project with Seminar, Internship, Project Work-1 and Project Work-2.

Each Theory and Laboratory course carries credits based on the number of hours / week as follows:

- **Lecture Hours (Theory):** 1 credit per lecture hour per week.
- **Laboratory Hours (Practical):** 1 credit for 2 practical hours, 2 credits for 3 or 4 practical hours per week.
- **Project Work:** 1 credit for 2 hours of project work per week.

8.1 Credit distribution for courses offered is shown in Table 3.

Table 3: Credit distribution

S. No	Course	Hours	Credits
1	Core Courses	3	3
2	Professional Core Elective Courses	3	3
3	Audit Courses	2	0
4	Laboratory Courses	4	2
5	Open Elective Courses	3	3
6	Mini Project with Seminar	2	2
7	Project Work-1 Dissertation	20	10
8	Project Work-2 Dissertation	32	16

8.2 Course wise break-up for the total credits:

Total Theory Courses (12) Core Courses (04)+Professional Core Electives (05) + Open Electives (01)	04@3credits + 05 @ 3 credits + 01@3 credits	30
Total Laboratory Courses (03)	04@2credits	08
Mini Project with Seminar(01)	1@2credit	02
Research Methodology and IPR	1@2 credit	02
Project Work-1	1 @10credit	10
Project Work-2	1 @16credits	16
TOTAL CREDITS		**68**

9.0 EVALUATION METHODOLOGY

9.1 Theory Course:

Each theory course will be evaluated for a total of 100 marks, with 30 marks for Continuous Internal Assessment (CIA) and 70 marks for Semester End Examination (SEE). Out of 30 marks allotted for CIE during the semester, marks are awarded by taking average of two sessional examinations.

9.1.1 Semester End Examination (SEE):

The SEE shall be conducted for 70 marks of 3 hours duration. The syllabus for the theory courses shall be divided into FIVE units and each unit carries equal weightage in terms of marks distribution. The question paper pattern shall be as defined below.Two full questions with 'either' 'or' choice will be drawn from each unit. Each question carries 14 marks. There could be a maximum of three sub divisions in a question.

The emphasis on the questions is broadly based on the following criteria:

50 %	To test the objectiveness of the concept
30 %	To test the analytical skill of the concept
20 %	To test the application skill of the concept

9.1.2 Continuous Internal Assessment (CIA):

For each theory course the CIA shall be conducted by the faculty/teacher handling the course as given in Table 4. CIA is conducted for a total of 30 marks, with 25 marks for Continuous Internal Examination (CIE) and 05 marks for Technical Seminar and Term Paper.

Table 4: Assessment pattern for Theory Courses

COMPONENT	**THEORY**		**TOTAL MARKS**
Type of Assessment	CIE Exam (Sessional)	Technical Seminar and Term Paper	
Max. CIA	25	5	30

Continuous Internal Examination (CIE):

Two CIE exams shall be conducted at the end of the 9th and 17th week of the semester respectively. The CIE exam is conducted for 25 marks of 2 hours duration, consisting of 5 one mark compulsory questions in part-A and 4 questions in part-B. The student has to answer any 4 questions out of five questions, each carrying 5 marks. Marks are awarded by taking average of marks scored in two CIE exams.

Technical Seminar and Term Paper:

Two seminar presentations are conducted during I year I semester and II semester. For seminar, a student under the supervision of a concerned faculty member, shall identify a topic in each course and prepare the term paper with overview of topic. The evaluation of Technical seminar and term paper is for maximum of 5 marks. Marks are awarded by taking average of marks scored in two Seminar Evaluations.

9.2 Laboratory Course:

Each lab will be evaluated for a total of 100 marks consisting of 30 marks for internal assessment and 70 marks for semester end lab examination. Out of 30 marks of internal assessment, continuous lab assessment will be done for 20 marks for the day to day performance and 10 marks for the final internal lab assessment. The semester end lab examination for 70 marks shall be conducted by two examiners, one of them being a internal examiner and another is external examiner, both nominated by the Principal from the panel of experts recommended by Chairman, BOS.

All the drawing related courses are evaluated in line with lab courses. The distribution shall be 30 marks for internal evaluation (20 marks for day–to–day work, and 10 marks for internal tests) and 70 marks for semester end lab examination. There shall be ONE internal test for 10 marks each in a semester.

9.3 Project work

Normally, the project work should be carried out at Host Institute (Institute of Aeronautical Engineering). However, it can also be carried out in any of the recognized Educational Institutions, National Laboratories, Research Institutions, Industrial Organizations, Service Organizations or Government Organizations with the prior permission from the guide and concerned Head of the Department. A student shall submit the outcome of the project work in the form of a dissertation.

9.3.1 The student shall submit the project work synopsis at the end of III semester for Phase-I of project evaluation. The Phase-I of project work shall be evaluated by Project Review Committee (PRC) at the end of the third semester for a maximum of 100 marks. Head of the Department (HOD) shall constitute a PRC comprising of senior faculty of the specialization, Guide and Head of the Department.

9.3.2 The first phase of project work is to be carried out in IV semester for Phase –II of Project work. The student will be allowed to appear for final viva voce examination at the end of IV semester only if s/he has submitted s/he project work in the form of paper for presentation/ publication in a conference/journal and produce the proof of acceptance of the paper from the organizers/publishers.

9.3.3 The student shall submit the project work in the form of dissertation at least four weeks ahead of the completion of the program. Head of the Department shall constitute an Internal Evaluation Committee (IEC) comprising of the Chairman BOS (PG), HOD and Guide. As per convenes of all meeting for open pre-submission seminar evaluation of the student. If the open pre-submission seminar by a student is not satisfactory, another seminar shall be scheduled within two weeks.

The evaluation of the project work and the marks allotted are as under:

S. No	Project Phases	Mode	Evaluation Committee	Marks
1	Phase - I	Continuous evaluation at the end of III Semester	Guide	30
2		Evaluation at the end of III Semester	Project Review Committee (PRC) comprising of senior faculty of the specialization, guide and HOD.	70
Total (Phase – I)				**100**
3	Phase - II	An open pre-submission seminar by the student	The Internal Evaluation Committee (IEC) comprising of the Chairman, BOS (PG), HOD and guide wherein the HOD convenes its meeting.	30
4		End Semester Examination (An open seminar followed by viva-voce)	The External Evaluation Committee (EEC) comprising of External Examiner, HOD and guide wherein the HOD shall be the chairman of the committee.	70
Total (Phase-II)				**100**

9.3.4 As soon as a student submits his project work, Principal shall appoint the External Examiner among the panel of examiners recommended by the Chairman, BOS (PG).

9.3.5 The Principal shall schedule the End Semester Examination in project work soon after the completion of the study of program and a student can appear for the same provided s/he has earned successfully all the requisite credits. The student shall produce the dissertation duly certified by the guide and HOD during the Examination.

9.3.6 The project reports of M.Tech students who have not completed their course work successfully will be evaluated in that semester itself and the result sent confidentially to the Controller of Examinations. The results of the project work evaluation will be declared by the Controller of Examinations only after the successful completion of the courses by those students.

10.0 ATTENDANCE REQUIREMENTS AND DETENTION POLICY

10.1 It is desirable for a candidate to put on 100% attendance in each course. In every course (theory/laboratory), student has to maintain a minimum of 80% attendance including the days of attendance in sports, games, NCC and NSS activities to be eligible for appearing in Semester End Examination of the course.

10.2 For cases of medical issues, deficiency of attendance in each course to the extent of 15% may be condoned by the College Academic Committee (CAC) on the recommendation of Head of the Department if his/her attendance is between 80% to 65% in every course, subjected to submission of medical certificate and other needful documents to the concerned department.

10.3 The basis for the calculation of the attendance shall be the period prescribed by the institute by its calendar of events. For late admission, attendance is reckoned from the date of admission to the program.

10.4 However, in case of a student having less than 65% attendance in any course, s/he shall be detained in the course and in no case such process will be relaxed.

10.5 Students whose shortage of attendance is not condoned in any subject are not eligible to write their semester end examination of that courses and their registration shall stand cancelled.

10.6 A prescribed fee shall be payable towards Condonation of shortage of attendance.

10.7 A candidate shall put in a minimum required attendance at least in three (3) theory courses for getting promoted to next higher class / semester. Otherwise, s/he shall be declared detained and has to repeat semester.

10.8 A student shall not be promoted to the next semester unless he satisfies the attendance requirement of the present semester, as applicable. They may seek readmission into that semester when offered next. If any candidate fulfills the attendance requirement in the present semester, s/he shall not be eligible for readmission into the same class.

11.0 CONDUCT OF SEMESTER END EXAMINATIONS AND EVALUATION

11.1 Semester end examination shall be conducted by the Controller of Examinations (COE) by inviting Question Papers from the External Examiners.

11.2 Question papers may be moderated for the coverage of syllabus, pattern of questions by Semester End Examination Committee chaired by Head of the Department one day before the commencement of semester end examinations.

11.3 Internal Examiner shall prepare a detailed scheme of valuation.

11.4 The answer papers of semester end examination should be evaluated by the internal examiner immediately after the completion of exam and the award sheet should be submitted to COE in a sealed cover before the same papers are kept for second evaluation by external examiner.

11.5 In case of difference is more than 15% of marks, the answer paper shall be re-evaluated by a third examiner appointed by the Examination Committee and marks awarded by him shall be taken as final.

11.6 HOD shall invite 3-9 external examiners to evaluate all the end semester answer scripts on a prescribed date(s). Practical laboratory exams are conducted involving external examiners.

11.7 Examination Control Committee shall consolidate the marks awarded by internal and external examiners to award grades.

12.0 SCHEME FOR THE AWARD OF GRADE

12.1 A student shall be deemed to have satisfied the minimum academic requirements and earn the credits for each theory course, if s/he secures:

i. Not less than 40% marks for each theory course in the semester end examination, and

ii. A minimum of 50% marks for each theory course considering both CIA and SEE

12.2 A student shall be deemed to have satisfied the minimum academic requirements and earn the credits for each Laboratory / Seminar and Technical Writing / Project, if s/he secures

i. Not less than 40% marks for each Laboratory / Seminar / Project course in the semester end examination,

ii. A minimum of 50% marks for each Laboratory / Mini project with Seminar / Project course considering both internal and semester end examination.

12.3 If a candidate fails to secure a pass in a particular course, it is mandatory that s/he shall register and reappear for the examination in that course during the next semester when examination is conducted in that course. It is mandatory that s/he should continue to register and reappear for the examination till s/he secures a pass.

13.0 LETTER GRADES AND GRADE POINTS

13.1 Performances of students in each course are expressed in terms of marks as well as in Letter Grades based on absolute grading system. The UGC recommends a 10point grading system with the following letter grades as given below:

Range of Marks	Grade Point	Letter Grade
90% and above (≥ 90% , ≤ 100%)	10	S (Superior)
Below 90% but not less than 80% (≥80% , <90%)	9	A+ (Excellent)
Below 80% but not less than 70% (≥70% , <80%)	8	A (Very Good)
Below 70% but not less than 60% (≥60% , <70%)	7	B+ (Good)
Below 60% but not less than 50% (≥ 50% , <60%)	6	B (Average)
Below 50% (< 50%)	0	F (Fail)
Absent	0	AB (Absent)
Authorized Break of Study	0	ABS

13.2 A student is deemed to have passed and acquired to correspondent credits in particular course if s/he obtains any one of the following grades: “S”, “A+”, “A”, “B+”, “B”.

13.3 A student obtaining Grade “F” shall be considered Failed and will be required to reappear in the examination.

13.4 “SA” denotes shortage of attendance (as per item 10) and hence prevention from writing Semester End Examination.

13.5 At the end of each semester, the institute issues grade sheet indicating the SGPA and CGPA of the student. However, grade sheet will not be issued to the student if s/he has any outstanding dues.

14.0 COMPUTATION OF SGPA AND CGPA

The UGC recommends to compute the Semester Grade Point Average (SGPA) and Cumulative Grade Point Average (CGPA). The credit points earned by a student are used for calculating the Semester Grade Point Average (SGPA) and the Cumulative Grade Point Average (CGPA), both of which are important performance indices of the student. SGPA is equal to the sum of all the total points earned by the student in a given semester divided by the number of credits registered by the student in that semester. CGPA gives the sum of all the total points earned in all the previous semesters and the current semester divided by the number of credits registered in all these semesters. Thus,

n n

$$SGPA = \sum_{i=1}^{n}(C_i G_i) / \sum_{i=1}^{n} C_i$$

Where, C_i is the number of credits of the i^{th} course and G_i is the grade point scored by the student in the i^{th} course and n represent the number of courses in which a student's is registered in the concerned semester.

$$CGPA = \sum_{j=1}^{m}(C_j S_j) / \sum_{j=1}^{m} C_j$$

Where, S_j is the SGPA of the j^{th} semester and $C_j$is the total number of credits upto the semester and m represent the number of semesters completed in which a student registered upto the semester. The SGPA and CGPA shall be rounded off to 2 decimal points and reported in the transcripts.

15.0 ILLUSTRATION OF COMPUTATION OF SGPA AND CGPA

15.1 Illustration for SGPA

Course Name	Course Credits	Grade letter	Grade point	Credit Point (Credit x Grade)
Course 1	3	A	8	3 x 8 = 24
Course 2	4	B+	7	4 x 7 = 28
Course 3	3	B	6	3 x 6 = 18
Course 4	3	S	10	3 x 10 = 30
Course 5	3	C	5	3 x 5 = 15
Course 6	4	B	6	4 x 6 = 24
	20			**139**

Thus, SGPA = 139 / 20 = 6.95

15.2 Illustration for CGPA

Semester 1	Semester 2	Semester 3	Semester 4
Credit: 20 SGPA: 6.9	Credit: 22 SGPA: 7.8	Credit: 25 SGPA: 5.6	Credit: 26 SGPA: 6.0

$$Thus,\ CGPA = \frac{20x6.9 + 22x7.8 + 25x5.6 + 26x6.0}{93} = 6.51$$

16.0 PHOTOCOPY / REVALUATION

A student, who seeks the revaluation of the answer script, is directed to apply for the photocopy of his/her semester examination answer paper(s) in the theory course(s) within 2 working days from the declaration of results in the prescribed format to the Controller of Examinations through the Head of the Department. On receiving the photocopy, the student can consult with a competent member of faculty and seek the opinion for revaluation. Based on the recommendations, the student can register for the revaluation with prescribed fee. The Controller of Examinations shall arrange for the revaluation and declare the results. Revaluation is not permitted to the courses other than theory courses.

17.0 GRADUATION REQUIREMENTS

The following academic requirements shall be met for the award of M .Tech degree.

17.1 Student shall register and acquire minimum attendance in all courses and secure 68 credits.

17.2 A student who fails to earn 68 credits within four consecutive academic years from the year of his/her admission with a minimum CGPA of 5.0, shall forfeit his/her degree and his/her admission stands cancelled.

18.0 AWARD OF DEGREE

Classification of degree will be as follows:

CGPA ≥ 7.5	CGPA ≥ 6.5 and < 7.5	CGPA ≥ 5.5 and < 6.5	CGPA ≥ 5.0 and < 5.5	CGPA < 5.0
First Class with Distinction	**First Class**	**Second Class**	**Pass Class**	**Fail**

a) In case a student takes more than one attempt in clearing a course, the final marks secured shall be indicated by * mark in the marks memo.

b) All the candidates who register for the semester end examination will be issued grade sheet by the Institute. Apart from the semester wise marks memos, the institute will issue the provisional certificate subject to the fulfillment of all the academic requirements.

19.0 IMPROVEMENT OF GRADE:

A candidate, after becoming eligible for the award of the degree, may reappear for the final examination in any of the theory courses as and when conducted for the purpose of improving the aggregate and the grade. But this reappearance shall be within a period of two academic years after becoming eligible for the award of the degree.

However, this facility shall not be availed of by a candidate who has taken the Original Degree Certificate. Candidates shall not be permitted to reappear either for CIE in any course or for Semester End Examination (SEE) in laboratory courses (including Project Viva-voce) for the purpose of improvement.

20.0 TERMINATION FROM THE PROGRAM

The admission of a student to the program may be terminated and the student may be asked to leave the institute in the following circumstances:

a) The student fails to satisfy the requirements of the program within the maximum period stipulated for that program.

b) The student fails to satisfy the norms of discipline specified by the institute from time to time.

21.0 WITH-HOLDING OF RESULTS

If the candidate has not paid any dues to the college / if any case of indiscipline / malpractice is pending against him/her, the results of the candidate will be withheld. The issue of the degree is liable to be withheld in such cases.

22.0 GRADUATION DAY

The institute shall have its own annual Graduation Day for the award of Degrees to students completing the prescribed academic requirements in each case, in consultation with the University and by following the provisions in the Statute.

The college shall institute prizes and medals to meritorious students annually on Graduation Day. This will greatly encourage the students to strive for excellence in their academic work.

23.0 DISCIPLINE

Every student is required to observe discipline and decorum both inside and outside the institute and not to indulge in any activity which will tend to bring down the honor of the institute. If a student indulges in malpractice in any of the theory / practical examination, continuous assessment examinations he/she shall be liable for punitive action as prescribed by the Institute from time to time.

24.0 GRIEVANCE REDRESSAL COMMITTEE

The institute shall form a Grievance Redressal Committee for each course in each department with the Course Teacher and the HOD as the members. This Committee shall solve all grievances related to the course under consideration.

25.0 TRANSITORY REGULATIONS

25.1 A student who has been detained in any semester of previous regulations for not satisfying the attendance requirements shall be permitted to join in the corresponding semester of this regulation.

25.2 Semester End Examination in each course under the regulations that precede immediately these regulations shall be conducted three times after the conduct of last regular examination under those regulations. Thereafter, the failed students, if any, shall take examination in the equivalent papers of these regulations as suggested by the Chairman, BOS concerned.

26.0 REVISION OF REGULATIONS AND CURRICULUM

The Institute from time to time may revise, amend or change the regulations, scheme of examinations and syllabi if found necessary and on approval by the Academic Council and the Governing Body shall come into force and shall be binding on the students, faculty, staff, all authorities of the Institute and others concerned.

FAILURE TO READ AND UNDERSTAND THE REGULATIONS IS NOT AN EXCUSE

INSTITUTE OF AERONAUTICAL ENGINEERING

(AUTONOMOUS)

AEROSPACE ENGINEERING

COURSE CATALOG – R18

I SEMESTER

Course Code	Course Name	Subject Area	Category	Periods per week			Credits	Scheme of Examination Max. Marks		
				L	T	P		CIA	SEE	Total
THEORY										
BAEB01	Advanced Mathematics in Aerospace Engineering	PCC	Core	3	0	0	3	30	70	100
BAEB02	Aerospace Propulsion	PCC	Core	3	0	0	3	30	70	100
	Professional Core Elective - I	PEC	Elective	3	0	0	3	30	70	100
	Professional Core Elective – II	PEC	Elective	3	0	0	3	30	70	100
	Audit Course – I	Audit - I	Audit	2	0	0	0	30	70	100
PRACTICAL										
BAEB09	Advanced Computational Aerodynamics Laboratory	PCC	Core	0	0	4	2	30	70	100
BAEB10	Computational Aerospace Engineering Laboratory	PCC	Core	0	0	4	2	30	70	100
TOTAL				**14**	**00**	**08**	**16**	**210**	**490**	**700**

II SEMESTER

Course Code	Course Name	Subject Area	Category	Periods per week			Credits	Scheme of Examination Max. Marks		
				L	T	P		CIA	SEE	Total
THEORY										
BAEB11	Flight Dynamics and Control	PCC	Core	3	0	0	3	30	70	100
BAEB12	Engineering Analysis of Flight Vehicles	PCC	Core	3	0	0	3	30	70	100
	Professional Core Elective – III	PEC	Elective	3	0	0	3	30	70	100
	Professional Core Elective - IV	PEC	Elective	3	0	0	3	30	70	100
	Audit Course – II	Audit - II	Audit	2	0	0	0	30	70	100
PRACTICAL										
BAEB19	Flight Simulation and Controls Laboratory	PCC	Core	0	0	4	2	30	70	100
BAEB20	Computational Structures Laboratory	PCC	Core	0	0	4	2	30	70	100
BAEB21	Mini Project with Seminar	PCC	Core	0	0	4	2	30	70	100
TOTAL				**14**	**00**	**12**	**18**	**240**	**560**	**800**

III SEMESTER

Course Code	Course Name	Subject Area	Category	Periods per week			Credits	Scheme of Examination Max. Marks		
				L	T	P		CIA	SEE	Total
THEORY										
BCSB31	Research Methodology and IPR	PCC	Core	2	0	0	2	30	70	100
	Professional Core Elective – V	PEC	Elective	3	0	0	3	30	70	100
	Open Elective	OE	Elective	3	0	0	3	30	70	100
PRACTICAL										
BAEB40	Phase-I Dissertation	Major Project	Core	0	0	20	10	30	70	100
TOTAL				**08**	**00**	**20**	**18**	**120**	**280**	**400**

IV SEMESTER

Course Code	Course Name	Subject Area	Category	Periods per week			Credits	Scheme of Examination Max. Marks		
				L	T	P		CIA	SEE	Total
BAEB41	Phase-II Dissertation	Major Project	Core	0	0	32	16	30	70	100
TOTAL				**00**	**00**	**32**	**16**	**30**	**70**	**100**

PROFESSIONAL CORE ELECTIVE COURSES

PROFESSIONAL COREELECTIVE – I

Course Code	Course Title
BAEB03	Fatigue & Facture
BAEB04	Aero Elasticity
BAEB05	Advance Computational Aerodynamics

PROFESSIONAL COREELECTIVE – II

Course Code	Course Title
BAEB06	Unmanned Aerial Vehicles
BAEB07	Design and analysis of composite structures
BAEB08	Experimental Aerodynamics

PROFESSIONAL CORE ELECTIVE – III

Course Code	Course Title
BAEB13	Guidance and Controls
BAEB14	Rocket and Missile
BAEB15	Ground Vehicle Aerodynamics

PROFESSIONAL CORE ELECTIVE – IV

Course Code	Course Title
BAEB16	Atmospheric re entry Vehicles
BAEB17	Hypersonic And High-Temperature Gas Dynamics
BAEB18	Turbo Machinery and Dynamics

PROFESSIONAL CORE ELECTIVE – V

Course Code	Course Title
BAEB22	Missile Aerodynamics
BAEB23	Flight Simulation
BAEB24	Airport Planning and Operations

OPEN ELECTIVE COURSES

OPEN ELECTIVE – I

Course Code	Course Title
BCSB25	Business Analytics
BCSB26	Industrial Safety
BCSB27	Operations Research
BCSB28	Cost Management of Engineering Projects
BCSB29	Composite Materials
BCSB30	Waste to Energy

AUDIT COURSES

Course Code	Course Title
BCSB32	English for Research Paper Writing
BCSB33	Disaster Management
BCSB34	Sanskrit for Technical Knowledge
BCSB35	Value Education
BCSB36	Constitution of India
BCSB37	Pedagogy Studies
BCSB38	Stress Management by Yoga
BCSB39	Personality Development through Life Enlightenment Skills

SYLLABUS

(I – III SEMESTERS)

ADVANCED MATHEMATICS IN AEROSPACE ENGINEERING

I Semester: AE

Course Code	Category	Hours / Week			Credits	Maximum Marks		
		L	T	P	C	CIA	SEE	Total
BAEB01	Core	3	-	-	3	30	70	100
Contact Classes: 45	**Tutorial Classes: Nil**		**Practical Classes: Nil**			**Total Classes: 45**		

I. COURSE OVERVIEW:

The course focuses on more advanced Engineering Mathematics topics which provide the relevant mathematical tools required in the analysis of problems in engineering and scientific professions. The course includes root-finding techniques, Interpolation, and its applications, parabolic equations, Hyperbolic equations, Elliptic equations with applications. The mathematical skills derived from this course form a necessary base for analytical and design concepts encountered in the program.

II. COURSE OBJECTIVES:

The course should enable the students to:

I. Develop a basic understanding of a range of mathematics tools with emphasis on engineering applications.
II. Solve problems with techniques from advanced linear algebra, ordinary differential equations and multivariable differentiation.
III. Develop skills to think quantitatively and analyze problems critically

III. COURSE OUTCOMES:

After successful completion of the course, students will be able to:

CO 1	**Calculate** the unknown values of given equal and unequal spaced data by using Numerical methods.	**Apply**
CO 2	**Make use of** Lagrange's method and method of separation of variables for solving linear and nonlinear partial differential equations.	**Apply**
CO 3	**Interpret** the boundary conditions for functions of Parabolic equations by using partial derivatives.	**Apply**
CO 4	**Solve** the Parabolic equations by using Crank-Nicholson implicit method.	**Apply**
CO 5	**Compute** the numerical solution of the Hyperbolic Equations by using method of characteristics.	**Apply**
CO 6	**Apply** the properties of Elliptic Equations for curved boundary analysis by the five-point approximation to Polman's equation.	**Apply**

IV. SYLLABUS:

UNIT-I	**PROBABILITY THEORY AND DISTRIBUTIONS**	**Classes: 09**

Theory Probability Theory and Sampling Distributions. Basic probability theory along with examples. Standard discrete and continuous distributions like Binomial, Poisson, Normal, Exponential etc. Central Limit Theorem and its significance. Some sampling techniques like chi-square, t, F distributions.

UNIT-II	**TESTING OF STATISTICAL HYPOTHESIS**	**Classes: 09**
Testing a statistical hypothesis, tests on single sample and two samples concerning means and variances. ANOVA: One – way, Two – way with / without interactions.		
UNIT-III	**ORDINARY DIFFERENTIAL EQUATIONS**	**Classes: 09**
Ordinary linear differential equations solvable by direct solution methods. Non linear ordinary differential equations, solvable by direct solution methods.		
UNIT-IV	**PARTIAL DIFFERENTIAL EQUATIONS AND CONCEPTS IN SOLUTION TO BOUNDARY VALUE PROBLEMS**	**Classes: 09**
First and second order partial differential equations; canonical forms		
UNIT-V	**NUMERIC'S FOR ORDINARY DIFFERENTIAL EQUATIONS AND PARTIAL DIFFERENTIAL EQUATIONS**	**Classes: 09**
Methods for first order ordinary differential equations, multistep methods, methods for systems and higher order ordinary differential equations, methods for elliptic partial differential equations, Neumann and mixed problems, irregular boundary, methods for parabolic and hyperbolic partial differential equations.		

Text Books:

1. J. B. Doshi, "Differential Equations for Scientists and Engineers", Narosa, New Delhi.
2. B. S. Grewal, "Higher Engineering Mathematics", Khanna Publishers, 43rd Edition, Delhi.

Reference Books:

1. S. P. Gupta, "Statistical Methods", S. Chand & Sons, 37th Revised Edition.
2. Erwin Kreyszig, "Advanced Engineering Mathematics", Wiley India, 9th Edition 2014.

Web References:

1. http://www.efunda.com/math/math_home/math.cfm
2. http://www.ocw.mit.edu/resourcs/#Mathematics
3. http://www.sosmath.com
4. http://www.mathworld.wolfram.com

E-Text Books:

1. http://www.keralatechnologicaluniversity.blogspot.in/2015/06/erwin-kreyszig-advanced-engineering-mathematics-ktu-ebook-download.html
2. http://www.faadooengineers.com/threads/13449-Engineering-Maths-II-eBooks

AEROSPACE PROPULSION

I Semester: AE

Course Code	Category	Hours / Week			Credits	Maximum Marks		
		L	T	P	C	CIA	SEE	Total
BAEB02	Core	3	-	-	3	30	70	100
Contact Classes: 45	Tutorial Classes: Nil	Practical Classes: Nil				Total Classes: 45		

I. COURSE OVERVIEW:

An aerospace propulsion system is a device that generates forces to push the aerospace vehicles forward. This course discusses about the various Aerospace propulsive devices in micro level, it includes an overview of different types of propulsive system present in aircrafts and rockets such as turbojet, turboprop, turbofan, IC engine, solid propellant, hybrid propellant and liquid propellant engines. Along with that design and analysis will be discussed on the various parameters and components present in aerospace propulsive system.

II. COURSE OBJECTIVES:

The course should enable the students to:

I. The basic working principles of different types of air breathing engines.
II. The design and analysis of IC engines.
III. The design of different components of gas turbine.
IV. The design of different components of solid and liquid propellant rockets.

III. COURSE OUTCOMES:

After successful completion of the course, students will be able to:

CO 1	**Identify** suitable air-breathing engine and operating system for the aircraft based on performance.	**Apply**
CO 2	**Distinguish** between the functions and performance parameters of inlets, nozzles, combustors and after burners for choosing desired devices to the aero engines.	**Apply**
CO 3	**Identify** the performance parameters for estimating the thrust and specific fuel consumption of an aircraft engine.	**Analyze**
CO 4	**Examine** the working procedure of rocket propulsion system and components for selecting them based on mission profile	**Analyze**
CO 5	**Make a use of** working principles of solid and hybrid rocket motors for increasing the performances level.	**Apply**
CO 6	**Develop** sub-systems and heat transfer systems in liquid propellant rocket for definitive deep space rocket propulsive design.	**Analyze**

IV. SYLLABUS:

UNIT-I	AIR-BREATHING ENGINES	Classes: 09

Classification, operational envelopes; Description and function of gas generator, turbojet, turbofan, turboprop, turboshaft, ramjet, scramjet, turbojet/ramjet combined cycle engine; Engine thrust, takeoff thrust, installed thrust, thrust equation; Engine performance parameters, specific thrust, specific fuel consumption and specific impulse, thermal efficiency, propulsive efficiency, engine overall efficiency and its impact on aircraft range and endurance; Engine cycle analysis and performance analysis for turbojet, turbojet with afterburner, turbofan engine, turboprop engine.

UNIT-II	AIRCRAFT ENGINE INLETS, EXHAUST NOZZLES, COMBUSTORS AND AFTERBURNERS	Classes: 09
Subsonic inlets: Function, design variables, operating conditions, inlet performance, performance parameters; Supersonic inlets: Compression process, types, construction, losses, performance characteristics; Exhaust nozzles: primary nozzle, fan nozzle, converging nozzle, converging-diverging nozzle, variable nozzle, and performance maps, thrust reversers and thrust vectoring, Combustors and Afterburners: Geometries, flame stability, ignition and engine starting, adiabatic flame temperature, pressure losses, performance maps, fuel types and properties.		
UNIT-III	**AXIAL FLOW COMPRESSORS AND TURBINES**	**Classes: 09**
Axial flow Compressors: Geometry, definition of flow angles, stage parameters, cascade aerodynamics, aerodynamic forces on compressor blades, rotor and stator frames of reference, compressor performance maps, velocity polygons or triangles, single stage energy analysis, compressor instability, stall and surge. Axial Flow Turbines: Geometry, configuration, comparison with axial flow compressors, velocity polygons or triangles, single stage energy analysis, performance maps, thermal limits of blades and vanes, blade cooling, blade and vane materials, blade and vane manufacture.		
UNIT-IV	**SOLID-PROPELLANT ROCKET MOTORS**	**Classes: 09**
Background description: Classification of rocket propulsion systems; Performance of an ideal rocket, rocket thrust equation, total and specific impulse, effective exhaust velocity, rocket efficiencies, characteristic velocity, thrust coefficient; Description of solid propellant rocket motor, solid propellant grain configurations, homogeneous propellant, heterogeneous or composite propellant, different grain cross sections, propellant burning rate, combustion of solid propellants, physical and chemical processes, ignition process, combustion instability; Hybrid propellant rockets: Hybrid rocket operation and hybrid rocket characteristics.		
UNIT-V	**LIQUID PROPELLANT ROCKET ENGINES: PROPELLANT TYPES**	**Classes: 09**
Bipropellant, monopropellant, cold gas propellant, cryogenic propellant, storable propellants, gelled propellant; Propellant Storage,different propellant tank arrangements, propellant feed system-pressure feed, turbopump feed; Thrust chambers, injectors, combustion chamber, nozzle, starting and ignition, variable thrust; Combustion of liquid propellants: Combustion process, combustion instability, thrust vector control.		

Text Books:

1. Ronald D. Flack, "Fundamentals of Jet Propulsion with Applications", Cambridge University Press, 3rd Edition, 2011.
2. George P. Sutton, Oscar Biblarz, "Rocket Propulsion Elements", Wiley India Pvt. Ltd, 7th Edition, 2010.

Reference Books:

1. Jack D. Mattingly, "Elements of Propulsion: Gas Turbines and Rockets", AIAA Education Series, Edition, 2006.
2. Saeed Farokhi, "Aircraft Propulsion", Wiley, 2nd Edition, 2014.
3. David R. Greatrix, "Powered Flight: The Engineering of Aerospace Propulsion", Springer, 3rd Edition , 2012.

Web References:

1. http://www.aero.iisc.ernet.in/page/propulsion
2. https://afreserve.com/aerospace-propulsion
3. http://ocw.mit.edu/courses/aeronautics-and-astronautics/16-50-introduction-to-propulsion-systems-spring-2012/Syllabus/

E-Text Books:

1. http://as.wiley.com/WileyCDA/WileyTitle/productCd-1118307984.html
2. http://www.freeengineeringbooks.com/AeroSpace/Propulsion-Books.php
3. http://www.springer.com/us/book/9781447124849?token=prtst0416p

FATIGUE AND FRACTURE

I Semester: AE

Course Code	Category	Hours / Week			Credits	Maximum Marks		
		L	T	P	C	CIA	SEE	Total
BAEB03	Elective	3	-	-	3	30	70	100
Contact Classes: 45	Tutorial Classes: Nil	Practical Classes: Nil				Total Classes: 45		

I. COURSE OVERVIEW:

Fracture mechanics and fatigue are essential to understanding the structural performance of real-world materials. Fracture mechanics is the study of the complex stress field around the tip of a crack and can be used to determine if an existing crack will propagate or arrest. Fatigue analysis is the study of fracture behavior under repeated cyclic loading. High cycle and low cycles fatigue are used in designing machine members subjected to various fatigue load conditions. Crack growth under fatigue and realistic conditions are analyzed which is used in the industries.

II. COURSE OBJECTIVES:

The course should enable the students to:

I. Give an understanding of phenomena and theories.
II. Provide an orientation on classical and modern methods and design criteria.
III. Teach basic numerical methods of design.
IV. Serve as an introduction for possible further studies.

III. COURSE OUTCOMES:

After successful completion of the course, students will be able to:

CO 1	**Apply** the concept of stress and number of cyclic loadings on a given specimen for deterring the endurance limit.	**Apply**
CO 2	**Analyze** the behavior of a specimen under High cycle and Low cycle fatigues for design against fatigue failure	**Analyze**
CO 3	**Apply** the mathematical principles to High cycle and Low cycle fatigues for determining the failure loads	**Analyze**
CO 4	**Analyze** the influence of crack growth under fatigue loads and surface roughness for designing the member to withstand the crack	**Analyze**
CO 5	**Analyze** the various methods involved in crack detections techniques for identifying the surface cracks.	**Analyze**
CO 6	**Illustrate** the various methods involved in fatigue testing for determining the Endurance limit.	**Apply**

IV. SYLLABUS:

UNIT-I	FATIGUE OF STRUCTURES	Classes: 08

S.N. curves, Endurance limit, Effect of mean stress, Goodman, Gerber and Soderberg relations and diagrams, Notches and stress concentrations, Neuber"s stress concentration factors, plastic stress concentration factors, Notched S-N curves.

UNIT-II	STATISTICAL ASPECTS OF FATIGUE BEHAVIOUR	Classes: 10
Low cycle and high cycle fatigue, Coffin-Manson's relation, Transition life, Cyclic Strain hardening and softening Analysis of load histories, Cycle counting techniques, Cumulative damage, Miner"s theory, other theories.		
UNIT-III	**PHYSICAL ASPECTS OF FATIGUE**	**Classes: 10**
Phase in fatigue life, Crack initiation, Crack growth, Final fracture, Dislocations, Fatigue fracture surfaces.		
UNIT-IV	**FRACTURE MECHANICS**	**Classes: 09**
Strength of cracked bodies, potential energy and surface energy, Griffith's theory, Irwin, Orwin extension of Griffith's theory to ductile materials, Stress analysis of cracked bodies, Effect of thickness on fracture toughness, Stress intensity factors for typical geometries.		
UNIT-V	**FATIGUE DESIGN AND TESTING**	**Classes: 08**
Safe life and fail safe design philosophies, Importance of Fracture Mechanics in aerospace structure, Application to composite materials and structures.		

Text Books :

1. D. Brock, "Elementary Engineering Fracture Mechanics", Noordh off International Publishing Co., London, 1994.
2. J. F. Knott, "Fundamentals of Fracture Mechanics", Butterworth & Co., (Publishers) Ltd., London, 1983.

Reference Books:

1. W. Barrois and L. Ripley, "Fatigue of Aircraft Structures", S Pergamon Press, Oxford,1983.
2. C. G. Sih, "Mechanics of Fracture", Vol.1 Sijthoff and Noordhoff International Publishing Co., Netherland,1989.
3. S.T. Rolfe and J.M. Barsom , "Fracture and Fatigue Control in Structure".

Web References:

1. http://ocw.mit.edu/courses/materials-science-and-engineering/3-35-fracture-and-fatigue-fall-2003.
2. http://www.eng.ox.ac.uk/solidmech/research/fatigue-fracture-mechanics.
3. http://www.fatiguefracture.com

E-Text Books:

1. https://books.google.co.in/books/about/Fatigue_and_Fracture.html?id=rE5K9zBrprAC&redir_esc=y
2. http://www.springer.com/us/book/9789024725809
3. https://www.scribd.com/doc/111356174/D-Broek-Elementary-Engineering-Fracture-MechanicsV

AEROELASTICITY

I Semester: AE

Course Code	Category	Hours / Week			Credits	Maximum Marks		
		L	T	P	C	CIA	SEE	Total
BAEB04	Elective	3	-	-	3	30	70	100
Contact Classes: 45	Tutorial Classes: Nil	Practical Classes: Nil			Total Classes: 45			

I. COURSE OVERVIEW:

Aeroelasticity is a study of behavior of aircraft structural components while submerged in a fluid. In simpler terms, it deals with the comprehension of elastic, aerodynamic and inertial forces on a body due to fluid flow around it. It is a combination of three distinct fields of aeronautical engineering *i.e.* aerodynamics, stability and control, and solid mechanics. This course, deals with static aeroelasticity as well as dynamic aero elasticity. Each category of aero elasticity will have specific importance and they shall take roots from one of the aforementioned three domains. Students shall go through the basics of aero elasticity till dynamic phenomenon such as flutter.

II. COURSE OBJECTIVES:

The course should enable the students to:

I. Outline importance of aero elasticity in flight vehicle design and classify static and dynamic aero elastic problems.
II. Describe structural dynamic and steady and unsteady aerodynamics aspects of airframe and its components and their role in aero elasticity.
III. Construct theoretical basis for the solution of static aero elastic problems an estimate loads and other critical speeds.
IV. Construct theoretical basis for the solution of flutter problems and estimate of flutter speeds.

III. COURSE OUTCOMES:

After successful completion of the course, students will be able to:

CO 1	**Illustrate** the S-N diagram for estimating the endurance limit (failure point) under mean and alternating stresses.	**Understand**
CO 2	**Apply** the fracture mechanics theories for materials (Ductile, Brittle) subjected to crack(s) for determining the conditions for failure.	**Apply**
CO 3	**Illustrate** the influence of material thickness, fracture toughness, and stress intensity factors for cracked bodies of various geometries for stress and strain patterns.	**Understand**
CO 4	**Identify** various types of composite materials used for constructing modern aircraft components and structures to reduce the weight.	**Apply**
CO 5	**Construct** the shear stress distribution in closed section beams subjected to torsion for minimizing stress intensity.	**Apply**
CO 6	**Apply** the theory of Moment Couple for better load resistance in aircraft applications.	**Apply**

IV. SYLLABUS:

UNIT-I	AEROELASTIC PHENOMENA	Classes: 08

Stability versus response problems; The aeroelastic triangle of forces; Aero elasticity in Aircraft Design; Prevention of aero elastic instabilities. Influence and stiffness coefficients. Coupled oscillations.

UNIT-II	DIVERGENCE OF A LIFTING SURFACE	Classes: 10
Simple two-dimensional idealizations; Strip theory, Integral equation of the second kind Exact solutions for simple rectangular wings, Semirigid‟ assumption and approximate solutions; Generalized coordinates, successive approximations, numerical approximations using matrix equations.		
UNIT-III	**STEADY STATE AEROLASTIC PROBLEMS**	**Classes: 08**
Loss and reversal of aileron control, critical aileron reversal speed, aileron efficiency, semi rigid theory and successive approximations, lift distribution, rigid and elastic wings. Tail efficiency, effect of elastic deformation on static longitudinal stability.		
UNIT-IV	**FLUTTER PHENOMENON**	**Classes: 10**
Non-dimensional parameters, stiffness criteria, dynamic mass balancing, dimensional similarity; Flutter analysis, two dimensional thin airfoils in steady incompressible flow, quasi steady aerodynamic derivatives; Galerkin method for critical flutter speed, stability of disturbed motion, solution of the flutter determinant, methods of determining the critical flutter speeds, flutter prevention and control.		
UNIT-V	**EXAMPLES OF AEROELASTIC PROBLEMS**	**Classes: 09**
Galloping of transmission lines and Flow induced vibrations of transmission lines, tall slender structures and suspension bridges.		

Text Books:

1. Y.C.Fung, “An Introduction to the Theory of Aero elasticity”, John Wiley & Sons Inc., New York, 2008.
2. E.G. Broadbent, “Elementary Theory of Aero elasticity”, Bun Hill Publications Ltd., 1986.

Reference Books:

1. R.L. Bisplinghoff, H.Ashley, and R.L. Halfmann, “Aero elasticity”, Edition Addison Wesley Publishing Co., Inc., 2nd Edition, 1996.
2. R.H. Scanlan and R. Rosenbaum, “Introduction to the study of Aircraft Vibration and Flutter”, Macmillan Co., New York,1981.
3. R. D. Blevins, “Flow Induced Vibrations”, Krieger Pub Co.,2001

Web References:

1. http://www.efunda.com/math/math_home/math.cfm
2. http://ocw.mit.edu/resources/#Mathematics
3. http://www.sosmath.com/
4. http://mathworld.wolfram.com/

E-Text Books:

1. http://www.e-booksdirectory.com/details.php?ebook=10166
2. http://www.e-booksdirectory.com/details.php?ebook=7400re

ADVANCED COMPUTATIONAL AERODYNAMICS

I Semester: AE

Course Code	Category	Hours / Week			Credits	Maximum Marks		
		L	T	P	C	CIA	SEE	Total
BAEB05	Elective	3	-	-	3	30	70	100
Contact Classes: 45	Tutorial Classes: Nil	Practical Classes: Nil				Total Classes: 45		

I. COURSE OVERVIEW:

This course deals with the theory behind the commercially available computational fluid dynamic softwares and numerical methods for theory of the fluid flows. The primary focus of this course is on most used, progressive numerical techniques and time dependent methods used to solve the partial differential equations. The students will learn about the boundary layer equations and its transformations. Generation of the grids and its types, various boundary conditions in a fluid flow at different conditions discussed. Philosophy of methods of characteristics for solving the supersonic flow is appreciated. Quintessential method for solving flow around an airfoil that is Panel Methods is addressed.

II. COURSE OBJECTIVES:

The course should enable the students to:

I. Explain the concept of panel methods, analyze various boundary conditions applied and demonstrate several searching and sorting algorithms.
II. Describe the initial methods applied in the process of CFD tools development their advantages and disadvantages over modern developed methods.
III. Demonstrate different methods evolved in analyzing numerical stability of solutions and evaluate the parameters over which the stability depends and their range of values.
IV. Understand advanced techniques and methods in time marching steps and identify different boundary conditions for different cases in CFD techniques.

III. COURSE OUTCOMES:

After successful completion of the course, students will be able to:

CO 1	**Apply** the flux approach, flux vector splitting, upwind reconstruction- evolution methods for solving the compressible flow problems using Euler's equations.	**Apply**
CO 2	**Make use of** the explicit, implicit, time split methods and approximate factorization schemes for obtaining the stabilized numerical solution of subsonic and supersonic nozzle flows.	**Understand**
CO 3	**Develop** the boundary layer transformation equations for steady external flows on airfoil, wings and aircraft using finite difference method.	**Apply**
CO 4	**Analyze** the structured, unstructured grids and dummy cells using physical boundary conditions for attaining the accurate results of fluid flow problems.	**Apply**
CO 5	**Identify** the characteristic lines and compatibility equations for designing the supersonic nozzle having shock free and isentropic flow.	**Apply**
CO 6	**Utilize** the effects of compressibility and viscosity on thin airfoil for establishing the numerical solution in aerodynamic problems.	**Analyze**

IV. SYLLABUS

UNIT-I	NUMERICAL SOLUTIONS	Classes: 10

Euler equations: Flux approach, Lax-Wendroff method, basic principles of upwind schemes, flux vector splitting, Steger Warming flux vector splitting, Van Leer flux vector splitting, Upwind reconstruction, evolution, Godunov's first order upwind method, Roe's first order upwind method.

UNIT-II	TIME DEPENDENT METHODS	Classes: 10

Stability of solution, explicit methods, FTFS, FTCS, FTBS, Leapfrog method, Lax method. Implicit methods: Euler's FTCS, Crank Nicolson method, description of Lax- Wendroff scheme, McCormack two step predictor corrector method, description of time split methods, approximate factorization schemes.

UNIT-III	BOUNDARY CONDITIONS	Classes: 09

Boundary Layer Equations: Setting up the boundary layer equations, flat plate boundary layer solution, boundary layer transformations, explicit and implicit discretization, solution of the implicit difference equations, integration of the continuity equation, boundary layer edge and wall shear stress, Keller-box scheme.

Concept of dummy cells, solid wall inviscid flow, viscous flow, farfield concept of characteristic variables, modifications for lifting bodies inlet outlet boundary, injection boundary, symmetry plane, coordinate cut, periodic boundaries, interface between grid blocks, flow gradients at boundaries of unstructured grids.

UNIT-IV	METHOD OF CHARACTERISTICS	Classes: 08

Philosophy of method of characteristics, determination of characteristic lines, two dimensional irrotational flow, determination of compatibility equations, unit processes, supersonic nozzle design by the method of characteristics, supersonic wind tunnel nozzle, minimum length nozzles, domain of dependence and range of influence.

UNIT-V	PANEL METHODS	Classes: 08

Basic formulation, boundary conditions, physical considerations, reduction of a problem to a set of linear algebraic equations, aerodynamic loads, preliminary considerations prior to establishing numerical solution, steps toward constructing a numerical solution, solution of thin airfoil with lumped vortex filament, accounting for effects of compressibility and viscosity.

Text Books:

1. Tannehill John C, Anderson Dale A, Pletcher Richard H, "Computational Fluid Mechanics and Heat Transfer", Taylor & Francis, 2nd Edition, 1997.
2. Chung T G, "Computational Fluid Dynamics", Cambridge University Press, 2nd Edition, 2010.
3. Katz Joseph and Plotkin Allen, "Low-Speed Aerodynamics", Cambridge University Press, 2nd Edition, 2006.

Reference Books:

1. Anderson J D, "Modern Compressible Fluid Flow", McGraw Hill 2nd Edition,1990.
2. Anderson J D, "Fundamentals of Aerodynamics", Tata McGraw Hill, 5th Edition, 2010.
3. Anderson J D, "Computational Fluid Dynamics", McGraw Hill, 1995.
4. Rathakrishnan E, "Gas Dynamics", Prentice-Hall India, 2004.

Web References:

1. https://s6.aeromech.usyd.edu.au/aerodynamics/index.php/sample-page/subsonic-aerofoil-and-wing-theory/2d-panel-methods/
2. www.wind.civil.aau.dk/lecture/8sem_CFD/Lecture1/Lecture1.pdf
3. personalpages.manchester.ac.uk/staff/david.d.apsley/lectures/comphydr/timedep.pdf

E-Text Books:

1. https://books.google.co.in/books/about/Advanced_Computational_Fluid_and_Aerodyn.html?id=dWS4jgEACAAJ&redir_esc=y.
2. https://www.scribd.com/doc/159468983/Low-Speed-Aerodynamics-Joseph-Katz-Alen-Plotkin
3. https://www.crcpress.com/Computational-Fluid-Mechanics-and-Heat-Transfer-Third-edition/Pletcher-Tannehill-Anderson/p/book/9781591690375.
4. https://www.faadooengineers.com/threads/8482-Computational-Fluid-Dynamics-Ebook-Ppt-Pdf-Download.

UNMANNED AERIAL VEHICLES

I Semester: AE

Course Code	Category	Hours / Week			Credits	Maximum Marks		
		L	T	P	C	CIA	SEE	Total
BAEB06	Elective	3	-	-	3	30	70	100
Contact Classes: 45	Tutorial Classes: Nil	Practical Classes: Nil				Total Classes: 45		

I. COURSE OVERVIEW:

The course focuses on fundamentals related to powered, aerial vehicle systems that do not carry a human operator, including the terminology related to unmanned air vehicle systems (UAS), subsystems, the basic design of UAS for stealth and reliability, and also provides insight into different types of airframes and power-plants. It imparts knowledge about navigation, communications, control, and stability of UAVs.The course is aimed to obtain knowledge also in certification, testing and deployment, and future applications.

II. COURSE OBJECTIVES:

The course should enable the students to:

I. Acquire the knowledge of various disciplines contributing to the design, development and deployment of UAVs.
II. Explain the design of UAV systems and their configuration.
III. Develop and deploy the UAV systems.

III. COURSE OUTCOMES:

After successful completion of the course, students will be able to:

CO 1	**Apply** the concept of major sub-systems, and performance Characteristics for designing the UAV/ UAS.	**Apply**
CO 2	**Identify** the appropriate communication, navigation and guidance systems for maneuvering of Unmanned Air Vehicles.	**Apply**
CO 3	**Categorize** the techniques of the stability and control of UAV for desired maneuvering of Unmanned Air Vehicles.	**Understand**
CO 4	**Analyze** the design and development of Unmanned Aircraft System for stealth, reliability and Manufacturing.	**Apply**
CO 5	**Identify** the appropriate testing and certification process for the development of UAS to meet the international standard.	**Apply**
CO 6	**Make use of** the concepts of network-centric operations for the deployment of UAS in field operations.	**Analyze**

IV. SYLLABUS:

UNIT-I	**INTRODUCTION TO UNMANNED AIRCRAFT SYSTEMS**	**Classes: 10**
Applications of UAS, categories of UAV systems, roles of unmanned aircraft, composition of UAV system.		
UNIT-II	**DESIGN OF UAV SYSTEMS-I**	**Classes: 08**

Introduction to design and selection of the systems-conceptual phase, preliminary design, detailed design; Aerodynamics and airframe configurations-Lift-induced Drag, Parasitic Drag, Rotary-wing Aerodynamics, Response to Air Turbulence, Airframe Configurations; Medium-range, Tactical Aircraft, Characteristics of Aircraft Types-Long-endurance, Long-range Role Aircraft, Medium-range, Tactical Aircraft, Close-range/Battlefield Aircraft, MUAV Types, MAV and NAV Types, UCAV, Novel Hybrid Aircraft Configurations, Aspects of Airframe Design: Scale Effects, Packaging Density, Aerodynamics, Structures and Mechanisms, Selection of power- plants, Modular Construction, Ancillary Equipment, Design for Stealth: Acoustic Signature, Visual Signature, Thermal Signature, Radio/Radar Signature, Payload Types: Non-dispensable and dispensable payloads.

UNIT-III	**DESIGN OF UAV SYSTEMS-II**	**Classes: 09**

Communications-Communication Media, Radio Communication, Mid-air Collision (MAC) Avoidance, Communications Data Rate and Bandwidth Usage, Antenna Type; Control and Stability: HTOL Aircraft, Convertible Rotor Aircraft, Payload Control, Sensors, Autonomy; Navigation: NAVSTAR Global Positioning System (GPS), TACAN, LORAN C, Inertial Navigation, Radio Tracking, Way-point Navigation; Launch and Recovery.

Design for Reliability: Determination of the Required Level of Reliability, Achieving Reliability, Reliability Data Presentation, Multiplexed Systems, Reliability by Design, Design for Ease of Maintenance; Design for Manufacture and Development

UNIT-IV	**THE DEVELOPMENT OF UAV SYSTEMS:**	**Classes: 10**

System Development and Certification-System Development, Certification, Establishing Reliability; System Ground Testing: UAV Component Testing, UAV Sub- assembly and Sub-system Testing, Testing Complete UAV, Control Station Testing, Catapult Launch System Tests, Documentation; System In- flight Testing: Test Sites, Preparation for In-flight Testing, In- flight Testing, System certification.

UNIT-V	**DEPLOYMENT AND FUTURE OF UAV SYSTEMS:**	**Classes: 08**

Operational trials and full certification; UAV System Deployment- Network-centric Operations (NCO), Teaming with Manned and Other Unmanned System; Naval, arm and air force roles, civilian, paramilitary and commercial roles.

Text Books:

1. Reg Austin, Wiley, "Unmanned Aircraft Systems, UAVS Design and Deployment", 2nd Edition, 2010.

Reference Books:

1. Richard K. Barnhart, Stephen B. Hottman, Douglas M. Marshall, Eric Shappee, (eds.), "Introduction to Unmanned Aircraft Systems", CRC Press, 2012.
2. Valavanis, Kimon P., Vachtsevanos, George J. "Handbook of Unmanned Aerial Vehicles" AIAA series, 3rd Edition, 2004.

Web References:

1. http://www.tndte.com
2. http://www.scribd.com
3. http://www.sbtebihar.gov.in
4. http://www.ritchennai.org

E-Text Books:
1. Corrosion.ksc.nasa.gov/electrochem_cells.htm 2. http://www.science.uwaterloo.ca/~cchieh/cact/applychem/watertreatment.html 3. http://www.acs.org/content/acs/en/careers/college-to-career/areas-of-chemistry/polymer-chemistry.html

DESIGN ANALYSIS OF COMPOSITE STRUCTURES

I Semester: AE

Course Code	Category	Hours / Week			Credits	Maximum Marks		
		L	T	P	C	CIA	SEE	Total
BAEB07	Elective	3	-	-	3	30	70	100
Contact Classes: 45	Tutorial Classes: Nil	Practical Classes: Nil			Total Classes: 45			

I. COURSE OVERVIEW:

The course focuses on properties of constituent materials and composite laminates, and also provides insight into different analysis approaches of composite materials. It imparts knowledge about different theories of analysis of laminated beams and plates. The course is aimed to obtain knowledge also in different failure theories and concepts of composite materials.

II. CORUSE OBJECTIVES:

The course should enable the students to:

I. Develop advance research and development projects on composite materials and its fabrication.
II. Classify the composite materials based on matrix and fibres.
III. Understand the methods for analysis the composite materials

III. COURSE OUTCOMES:

After successful completion of the course, students will be able to:

CO 1	**Apply** the knowledge of properties of constituent materials to analyse the composite materials	**Apply**
CO 2	**Develop** stress-strain relations of isotropic, orthotropic, and anisotropic composite materials to design the composite laminates	**Apply**
CO 3	**Apply** the knowledge of classical lamination theory for analysing various composite materials	**Apply**
CO 4	**Explain** the mechanical behavior of layered composites compared to isotropic materials	**Understand**
CO 5	**Develop** relationships of mechanical loads applied to a laminate to analyze the strains and stresses in each lamina	**Apply**
CO 6	**Identify** the failure of individual lamina in a laminate to analyze the failure criteria of composite laminates	**Apply**

IV. SYLLABUS:

UNIT-I	**PROPERTIES OF CONSTITUENT MATERIALS & COMPOSITE LAMINATES**	**Classes: 09**

Introduction to laminated composite plates- mechanical properties of constituent materials such as matrices and filaments of different types. Netting analysis of composite materials, determination of properties of laminates with fibers and matrices.

UNIT-II	**ELASTIC PROPERTIES**	**Classes: 09**

Stress-strain relations of isotropic, orthotropic and anisotropic materials, transformation of material properties for arbitrary orientation of fibers.

UNIT-III	METHODS OF ANALYSIS- I & METHODS OF ANALYSIS- II	Classes: 09
Mechanics of materials approach to determine Young's modulus, shear modulus and Poisson's ratio. Brief mention of elasticity approach and macro mechanics of laminates. Anisotropic elasticity, stress –strain relations in material coordinates - Transformation of geometric axes, strength concepts, biaxial strength theories, maximum stress and maximum strain.		
UNIT-IV	**ANALYSIS OF LAMINATED BEAMS AND PLATES**	**Classes: 09**
Classical plate theory, Classical lamination theory – Special cases of single layer, symmetric, antisymmetric & unsymmetric composites with cross ply, angle ply layup. Deflection analysis of laminated plates, Analysis of laminated beams and plates.		
UNIT-V	**SHEAR DEFORMATION ANALYSIS & BUCKLING ANALYSIS**	**Classes: 09**
Shear deformation theories for composite laminated beams, plates- first, second and third order theories. nth order theory. Buckling analysis of laminated composite plates with different orientation of fibers, Tsai-wu criteria and Tsai – Hill Criteria.		

Text Books:

1. Agarwal.B.D, Broutman.L.J, "Analysis and Performance of Fibre Composites", John Wiley and sons, New York,1980.
2. Lubin.G, Von. Nostrand, "Advanced Plastics and Fibre Glass", Reinhold Co.Newyork, 1989.

Reference Books:

1. Gupta.L, Advanced Composite Materials, Himalayan Books, New Delhi, 1998.
2. Jones.R.M, Mechanics of Composite Materials, McGraw Hill Kogakusha ltd. Tokyo.
3. Reddy. J.N, Mechanics of Composite Materials.

Web References:

1. http://onlinelibrary.wiley.com/book.
2. https://www.asme.org/products/courses/design-analysis-fabrication-composite-structures.
3. http://as.wiley.com/WileyCDA/WileyTitle/productCd-1118401603.html

E-Text Books:

1. https://www.bookshout.com/ebooks/design-and-analysis-of-composite-structures
2. https://www.overdrive.com/media/1303069/design-and-analysis-of-composite-structures
3. http://www.lehmanns.de/technik/25035754-9781119957065-design-and-analysis-of-composite-structures

EXPERIMENTAL AERODYAMICS

I Semester: AE

Course Code	Category	Hours / Week			Credits	Maximum Marks		
		L	T	P	C	CIA	SEE	Total
BAEB08	Elective	3	-	-	3	30	70	100
Contact Classes: 45	Tutorial Classes: Nil		Practical Classes: Nil			Total Classes: 45		

I. COURSE OVERVIEW:

The experimental aerodynamics is the first course for graduate and undergraduate students in Aerospace Engineering. The testing methodology employed in low and high-speed aerodynamics is a new techniques through which the students will learn various types of wind tunnels, tools and techniques. The experimental aerodynamics will be helpful to industrial aerodynamics study in various engineering branches like, environmental engineering, civil engineering, Automobile engineering etc., so that students get exposure to the various aspects of the subject related issues to measuring techniques, wind tunnel design, method and practical applications used. This subject will help the students to develop the tool by using multidisciplinary techniques. A number of problems/examples will be cited to enhance the understanding of the subject matter and besides, many unsolved problems will be provided with answers to further test the student's learning.

II. COURSE OBJECTIVES:

The course should enable the students to:

I. Identify different components of wind tunnel and their function.
II. Estimate pressure distribution on airfoil, sphere, cylinder other aerodynamic surfaces and bluff body.
III. Perform experiment to measure forces on a model force balance.
IV. Perform experiment to determine boundary layer.
V. Determine flow visualization techniques.

III. COURSE OUTCOMES:

After successful completion of the course, students will be able to:

CO 1	**Explain** the need of wind tunnel and its measuring techniques for analysis of model using geometric similarity, kinematic similarity and dynamic similarity.	**Understand**
CO 2	**Identify** the principal components of low-speed wind tunnel and their functions for determining loss coefficients and constraints.	**Apply**
CO 3	**Demonstrate** low speed wind tunnel balances, mechanical and Strain gauge types, null displacement methods and strain method and etc for load measurement using wind tunnel balance.	**Apply**
CO 4	**Identify** the principles of probes and transducers used in pressure, velocity & temperature measurements techniques.	**Apply**
CO 5	**Identify** the necessity of streamlines, streak lines, path lines, time lines, tufts, china clay, oil film, and smoke and hydrogen bubble for flow visualization of wind in wind tunnel.	**Apply**
CO 6	**Identify** the applications of wind tunnels for the analysis of load, pressure, velocity and temperature measurements using flow visualization for the analysis of aerodynamic problems in automobile and aerospace industries.	**Apply**

SYLLABUS:

UNIT-I	**AERODYNAMIC EXPERIMENTS- HISTORY, MODEL TESTNG AND WIND TUNNELS- TYPES, APPLICATION**	**Classes: 08**

Forms of aerodynamic experiments: observation, measurement, objectives, history, means; Model testing- wind tunnel, principles, scaling laws, scale parameters, significance; Wind tunnels, low speed types, description; High speed tunnels, transonic, supersonic, hypersonic, shock tubes, special tunnels, low turbulence, high Re, environmental, automobile, function, distinctive features, application; Major wind tunnel facilities- description, details.

UNIT-II	LOW SPEED WIND TUNNELS- CONSTRUCTION, COMPONENTS, PERFORMANCE & WIND TUNNEL CORRECTIONS	Classes: 10

Low speed wind tunnel, principal components, working section, diffuser, corners, turning vanes, fan, straighteners, honeycombs, screens, contraction cone, fan, motor- function, description, design requirements, constraints, construction, performance- loss coefficients; Wind tunnel performance, flow quality, power losses; Wind tunnel corrections; Sources of inaccuracies, buoyancy, solid blockage, wake blockage, streamline curvature- causes, estimation, and correction; Total correction on airspeed, dynamic pressure, zero lift drag.

UNIT-III	LOAD MEASUREMENTS- WIND TUNNEL BALANCES AND FLOW MEASUREMENTS- INSTRUMENTATION	Classes: 10

Load measurements, wind tunnel balances, types, description, application; Steady and unsteady pressure measurements and various types of pressure probes and transducers, errors in pressure measurements.

Measurement of temperature using thermocouples, resistance thermometers, temperature sensitive paints and liquid crystals; Measurement of airspeed, flow direction, boundary layer profile using Pitot static tubes, 5 hole probes, total head rake- function, working principle, types, details of design and construction,use.

UNIT-IV	FLOW VISUALISATION TECHNIQUES	Classes: 09

Flow visualization, need, types, tufts, china clay, oil film, smoke, working principle, description, setting up, operation, observation, recording, interpretation of imagery, relative merits, applications; High speed flows, optical methods, shadow graphy, Schleiren, interferometry.

UNIT-V	MEASUREMENT OF VELOCITY- HOTWIRE ANEMOMETRY, LASER DOPPLER ANEMOMETRY, PARTICLE IMAGE VELOCIMETRY- OVERVIEW	Classes: 08

Hot wire anemometry, laser Doppler anemometry, particle image velocimetry, working principles, description of equipment, experimental setup, settings, calibration, measurement, data processing , applications.

Text Books :

1. Low Speed Wind Tunnel Testing, Barlow, J.B., Rae, W.H., Pope, A., Wiley1999.
2. High Speed Wind Tunnel Testing, Pope, A. and Goin, K.L., Wiley, 1965.
3. Yang, W.J., Handbook of Flow Visualization, 2nd edition, Taylor and Francis, 2001.

Reference Books:

1. Bradshaw, P., Experimental Fluid Mechanics, Pergamon Press, 1970.
2. Goldstein, R.J., (Ed.) Fluid Mechanics Measurements, Taylor Francis, Washington 1996.
3. Tropea, C., Yarin, A. L., Foss, J. F., Handbook of Experimental Fluid Mechanics, Springer, 2007.

Web References:

1. www.mace.manchester.ac.uk/our-research/research-themes/.../aerodynamics/
2. ocw.metu.edu.tr/pluginfile.php/1876/mod_resource/.../0/.../AE547_1_Outline1.pdf
3. https://www.coursehero.com/file/13548586/AE547-1-Outline1pdf/

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E-Text Books:
1. https://books.google.co.in/books?isbn=0471694029 2. https://books.google.co.in/books?id=VxchAAAAMAAJ 3. http://as.wiley.com/WileyCDA/WileyTitle/productCd-0471557749.html 4. http://www.gbv.de/dms/ilmenau/toc/318379147.PDF

ADVANCED COMPUTATIONAL AERODYNAMICS LABORATORY

VI Semester: AE

Course Code	Category	Hours / Week			Credits	Maximum Marks		
		L	T	P	C	CIA	SEE	Total
BAEB09	Core	-	-	4	2	30	70	100
Contact Classes: Nil	Tutorial Classes: Nil	Practical Classes: 36				Total Classes: 36		

I. COURSE OVERVIEW:

The major emphasis of this course is to solve a complex geometrical structures under a given loads, these methods does not have analytical solutions. Software's like ANSYS and NASTRAN is utilized to interpret results for complex geometries. Modeling of crack and composite structures help the students to solve realistic problems which are common in industries. Structural analysis on aircraft structures and Rocket components are delt to obtain the solution for bending and torsion under the applied aerodynamic loads.

II. COURSE OBJECTIVES:

The course should enable the students to:

I. Experience in computing aerodynamic problems and understanding flow physics over the objects.
II. Knowledge in estimating flow analysis for different mach numbers.
III. Determining the aerodynamic forces like mainly lift and drag.
IV. Analyze the errors and cause of errors in computational analysis.

III. COURSE OUTCOMES:

After successful completion of the course, students will be able to:

CO 1	**Apply** the philosophy behind the computational fluid dynamics for recognizing flow properties in solving fluids and heat transfer problems.	**Apply**
CO 2	**Select** the structured, unstructured mesh and multi-blocking strategy in basic, complex geometries and flow domains for computing aerodynamic characteristics.	**Apply**
CO 3	**Identify** the appropriate physical boundary conditions for attaining the precise results of fluid flow over a body.	**Understand**
CO 4	**Choose** the suitable numerical modeling and schemes for computational simulations of aerodynamics and thermo-fluid problems using ANSYS.	**Understand**
CO 5	**Analyze** the numerical solution of fluid flow problems using flow visualization Software's for recognizing the flow physics in and around the supersonic intake and free jet.	**Analyze**
CO 6	**Develop** the numerical code for one dimensional heat and wave equation using explicit finite difference method.	**Apply**

LIST OF EXPERIMENTS

Week-1	**INTRODUCTION**

Introduction to computational aerodynamics, the major theories, approaches and methodologies used in computational aerodynamics. Applications of computational aerodynamics for classicalaerodynamic's problems.

Week-2	**INTRODUCTION TO ANSYS CFX**

Introduction to gambit, geometry creation, suitable meshing types and boundary conditions.

Week-3	**INTRODUCTION TO ANSYS FLUENT**
Introduction to fluent, boundary conditions, solver conditions and post processing results.	
Week-4	**FLOW THROUGH NOZZLE**
Flow Through Nozzle	
Week-5	**FLOW THROUGH SUPERSONIC INTAKE**
Flow Through Supersonic Intake	
Week-6	**SUPERSONIC FREE JET**
Flow over a Supersonic Free Jet	
Week-7	**SHOCK BOUNDARY LAYER INTERACTION**
Shock Boundary Layer Interaction).	
Week-8	**FLOW OVER A RE-ENTRY VEHICLES**
Flow over a re- entry vehicle	
Week-9	**SUPERSONIC FLOW OVER A CONE**
Flow over wedge body at supersonic Mach number; observe the shock wave phenomena and change of properties across the shock wave.	
Week-10	**THERMAL TESTING TURBINE BLADE**
Flow over a Missile body	
Week-11	**CASCADE TESTING COMPRESSOR BLADE**
Solution for the following equations using finite difference method I. One dimensional wave equation using explicit method of lax. II. One dimensional heatconduction equation using explicit method.	
Week-12	**HEAT CONDUCTION**
I. One dimensional heat conduction equation using explicit method.	

Reference Books:

1. Anderson, J.D., Jr., Computational Fluid Dynamics The Basics with Applications, McGraw-Hill Inc, 1st Edition 1998.
2. Hoffmann, K. A. and Chiang, S. T., "Computational Fluid Dynamics for Engineers", 4th Edition, Engineering Education Systems (2000).
3. Hirsch, C., "Numerical Computation of Internal and External Flows: The Fundamentals of Computational Fluid Dynamics", Vol. I, 2nd Edition, Butterworth-Heinemann (2007).
4. JAF. Thompson, Bharat K. Soni, Nigel P. Weatherill "Grid generation", 1st Edition 2000.

Web References:

1. https://www.scribd.com/doc/311680146/eBook-PDF-Cfd-Fluent.
2. https://cfd.ninja/tutorials/ansys-fluent
3. https://confluence.cornell.edu/display/SIMULATION/FLUENT+Learning+UNITs

COMPUTATIONAL AEROSPACE ENGINEERING LABORATORY

I Semester: AE

Course Code	Category	Hours / Week			Credits	Maximum Marks		
		L	T	P	C	CIA	SEE	Total
BAEB10	Core	-	-	4	2	30	70	100
Contact Classes: Nil	Tutorials: Nil	Practical Classes: 36			Total Classes: 36			

I. COURSE OVERVIEW:

This course aims to enhance the skills through a detailed introduction to the state-of-the-art computational methods and their applications for digital age aerospace engineering applications. It provides a unique opportunity for cross-disciplinary education and knowledge transfer in the computational engineering of fluid and solid mechanics for aerospace industrial applications. Focusing on fully integrated digital design for aerospace applications, you will be able to understand and implement numerical methods on various computing platforms for aerospace applications.

II .COURSE OBJECTIVES:

The course should enable the students to:

I. Learn basic MATLAB software and use them to solve structural aerodynamic and flight control system problems.
II. Understand the basics of plotting in MATLAB both in two dimensional and three dimensional.
III. Develop codes for solving structural response problems, aerodynamic simulation problems and flight control system analysis and design.

COURSE OUTCOMES:

After successful completion of the course, students will be able to:

CO1	**Make use of** MATLAB and Simulink tools for solving aerospace engineering problems in designing.	**Apply**
CO2	**Examine** the thin-walled beams and shells using finite element method for analyzing the bending stiffness of aircraft structure.	**Analyze**
CO3	**Solve** the Burger's equation using explicit Mac Cormack method for analyzing fluid flows.	**Analyze**
CO4	**Develop** the numerical code for solving laminar flow over a flat plate.	**Analyze**
CO5	**Make use of** MATLAB and Simu-link for simulating the motion of aircraft and re-entry vehicles.	**Analyze**
CO6	**Build** the mathematical model by using different techniques for simulating satellite attitude dynamics.	**Analyze**

LIST OF EXPERIMENTS

Week-1	**MATLAB/SIMULINK FUNDAMENTALS FOR AEROSPACE APPLICATIONS**

MATLAB introduction, Plotting and graphics: Plot, log and semi-log plots, polar plots; Subplots, axis, mesh, contour diagrams, flow diagrams, movies, MATLAB tool boxes: continuous transfer functions, root locus, Nichols chart, Nyquist chart, linear quadratic regulator, state space design, digital design, aerospace toolbox; M cells, structures and M-files, MEX files; Standard simulink libraries, simulink aerospace blockset, Building simulink linear models: transfer function modelling in simulink, zero pole model, state-space model; simulink LTI viewer and usage of it, equivalent simulink LTI models, single input single output design tool, building Multi-input, multi output models, building simulink S-functions; State flow introduction: Opening, executing, and saving state flow models, constructing a simple state flow model, using a state flow truthtable.	
Week-2	**THIN-WALLED BEAMS**
Software development for thin-walled beams using finite element method.	
Week-3	**PLATE BENDING**
Software development for Plate bending using finite element method.	
Week-4	**BEAMS ANALYSIS**
Software development for Beams analysis using finite element method.	
Week-5	**TRUSSES ANALYSIS**
Software development for Trusses analysis using finite element method.	
Week-6	**THIN SHELLS ANALYSIS**
Software development for Thin shells analysis using finite element method.	
Week-7	**GENERATION OF STRUCTURES AND UNSTRUCTURED**
Software development for simulation in generation of structures and unstructured grids in two and Three dimensions of fluid flows.	
Week-8	**SOLUTION OF BURGERS EQUATION**
Software development for simulation in solution of burgers equation using explicit McCormack method of fluid flows.	
Week-9	**BLASIUS SOLUTION FOR LAMINAR BOUNDARY LAYER OVER A FLAT PLATE**
Software development for simulation in Blasius solution for laminar boundary layer over a flat plate of fluid flows.	
Week-10	**RIEMANN SOLVER FOR SHOCK TUBE PROBLEM**
Software development for simulation in Riemann solver for shock tube problem of fluid flows.	
Week-11	**SIMULATION OF AIRCRAFT MOTION**
Simulation experiment in dynamics and control using MATLAB and Simulink to Simulate aircraft motion such as longitudinal dynamics, lateral dynamics.	
Week-12	**SIMULATION OF AIRCRAFT MOTION WITH ILLUSTRATION OF F-16 MODEL**
Six-degrees-of-freedom simulation of aircraft motion with illustration of F-16 model using MATLAB and Simulink.	
Week-13	**SIMULATION OF RE-ENTRY VEHICLE DYNAMICS**
Simulation of re-entry vehicle dynamics for ballistic re-entry and maneuvering re-entry.	

Week-14	SIMULATION OF NON-LINEAR CONTROL SYSTEM
Simulation of non-linear control system for controlling roll dynamics of a fighter aircraft.	
Week-15	**SIMULATION OF SATELLITE ATTITUDE DYNAMICS**
Simulation of the following relating to satellite attitude dynamics: a. Torque free rotation of axisymmetric and asymmetric spacecraft. b. Attitude maneuvers of spin- stabilized spacecraft.	

Reference Books:

1. Richard Colgren, "Basic MATLAB, Simulink, and State Flow", AIAA Education Series, 1st Edition, 2007.
2. Steven T. Karris, "Introduction to Simulink with Engineering Application", Orchard Publication, 3rd Edition, 2006.
3. Ashish Tewari, "Atmospheric and Space Flight Dynamics", Birkhauser Publication, 1st Edition,2007
4. A. Tewari, "Modern Control Design with MATLAB and Simulink", Wiley, 1st Edition, 2002.

Web References:

1. http://www.springer.com/us/book/9780817644376
2. https://www.scribd.com/doc/53680598/Modern-Control-Design-With-MATLAB-and-SIMULINK

FLIGHT DYNAMICS AND CONTROL

II Semester: AE

Course Code	Category	Hours / Week			Credits	Maximum Marks		
		L	T	P	C	CIA	SEE	Total
BAEB11	Core	3	-	-	3	30	70	100
Contact Classes: 45	Tutorial Classes: Nil	Practical Classes: Nil			Total Classes: 45			

I. COURSE OVERVIEW:

Flight dynamics and control is the study of the performance, stability, and control of vehicles flying through the air or in outer space. It is concern with how the forces/moments are acting on the vehicle to determine its velocity and attitude with respect to time. This course is going to develop as an engineering science throughout succeeding generations of aircraft engineer to support increasing demands of aircraft stability and control and it now has a major role to play in the design of modern aircraft to ensure efficient, comfortable and safe flight. Modern aircraft control is ensured through automatic control systems known as autopilot. Their role is to increase safety, facilitate the pilot's task and improve flight qualities. The course will introduce modern aircraft stability and control and discuss some of its objectives and applications.

II. COURSE OBJECTIVES:

The course should enable the students to:

I. Review basics of stability and control performance of aircraft.
II. Develop governing equation of motions for aircraft.
III. Convert nonlinear equation to a set of linear equation using small perturbation.
IV. Identify different types of instabilities encounter in longitudinal and lateral motion.

III. COURSE OUTCOMES:

After successful completion of the course, students will be able to:

CO 1	**Make use of** the principles of flight and governing aerodynamics laws for the control of aircraft motions forgetting the desired aircraft attitude characteristics.	**Understand**
CO 2	**Model** the range, endurance and stability of equilibrium under different types of motions for calculating the aerodynamic performance of an airplane.	**Understand**
CO 3	**Analyze** the concept of aircraft dynamics, equations of motion in linear and nonlinear motion for optimal flight conditions.	**Apply**
CO 4	**Determine** the linear equations off motion and derivatives for the coupled and decoupled motion in terms of stability axis system by using small perturbation theory for obtaining the state of dynamic stability.	**Understand**
CO 5	**Develop** the mathematical model for the dynamic and static stability and its derivatives by using computational numerical simulation for the different types of aircrafts.	**Apply**
CO 6	**Examine** the flight control system by using control theories and modern computational tools system for the conventional and automatic flight of the aircraft.	**Analyze**

IV. SYLLABUS:

UNIT-I	**INTRODUCTION**	**Classes: 09**

Basic principles of flight; Flying control surfaces: Elevator, ailerons and rudder; Pilot"s controls: The throttle, the control column, modes of flight; Basic principles governing aerodynamic flows: Introduction, continuity principle, Bernoulli"s principle, laminar flows and boundary layers, turbulent flows, aerodynamics of airfoils and wings, slender body aerodynamics, wing-body interference, empennage aerodynamics, aerodynamics of complete aircraft, aerodynamic forces and moments.

UNIT-II	MECHANICS OF EQUILIBRIUM FLIGHT	Classes: 09

Introduction, speeds of equilibrium flight, basic aircraft performance, conditions for minimum drag, range and endurance estimation, trim, stability of equilibrium flight, longitudinal static stability, maneuverability, lateral stability and stability criteria, experimental determination of aircraft stability margins; Aircraft non- linear dynamics; Equations of motion, introduction, aircraft dynamics, aircraft motion in a two dimensional plane, moments of inertia, Euler"s equations and the dynamics of rigid bodies, aircraft equations of motion, motion-induced aerodynamic forces and moments, non-linear dynamics of aircraft motion, trimmed equations of motion.

UNIT-III	SMALL PERTURBATIONS AND THE LINEARISED, DECOUPLED EQUATIONSOF MOTION	Classes: 09

Small perturbations and linearization; Linearizing the aerodynamic forces and moments: Stability derivative concept, direct formulation in the stability axis, decoupled equations of motion, decoupled equations of motion in terms of the stability axis aerodynamic derivatives, decoupled equations of motion in terms of the stability axis aerodynamic derivatives.

Non-dimensional longitudinal and lateral dynamics; Simplified state-space equations of longitudinal and lateral dynamics, simplified concise equations of longitudinal and lateral dynamics.

UNIT-IV	LONGITUDINAL AND LATERAL LINEAR STABILITY AND CONTROL	Classes: 09

Dynamic and static stability, modal description of aircraft dynamics and the stability, aircraft lift and drag estimation, estimating the longitudinal aerodynamic derivatives, estimating the lateral aerodynamic derivatives, aircraft dynamic response, numerical simulation and non-linear phenomenon longitudinal and lateral modal equations, methods of computing aircraft dynamic response, system block diagram representation, atmospheric disturbance, deterministic disturbances, principles of random atmospheric disturbance modeling, application to atmospheric turbulence modeling, aircraft non-linear dynamic response phenomenon.

UNIT-V	AIRCRAFT FLIGHT CONTROL	Classes: 09

Automatic flight control systems: An introduction, functions of a flight control system, integrated flight control system, flight control system design.

Text Books:

1. Vepa, R., "Flight Dynamics, Simulation and Control: For Rigid and Flexible Aircraft", CRC Press, Taylor and Francis Group, 2015.

Reference Books:

1. Wayne Durham, "Aircraft Flight Dynamics and Control", CRC Press, 2nd Edition 2013.
2. Robert F. Stengel "Flight Dynamics". CRC Press, 2nd Edition 2013.

Web References:

1. http://www.engin.umich.edu/aero/research/areas/controls
2. http://nptel.ac.in/courses/101106043/
3. http://www.princeton.edu/~stengel/MAE331Lectures.html

E-Text Books:

1. http://as.wiley.com/WileyCDA/WileyTitle/productCd-1118646819.html
2. http://press.princeton.edu/titles/7909.html
3. http://www.slideshare.net/turnt/aircraft-flight-dynamics-and-control-33771964

ENGINEERING ANALYSIS OF FLIGHT VEHICLES

II Semester: AE

Course Code	Category	Hours / Week			Credits	Maximum Marks		
		L	T	P	C	CIA	SEE	Total
BAEB12	Core	3	-	-	3	30	70	100
Contact Classes: 45	Tutorial Classes: Nil	Practical Classes: Nil			Total Classes: 45			

I. COURSE OVERVIEW:

Computational science and engineering involves the development and use of computational methods to simulate, predict, and understand important phenomena in this subject. The aerospace field is characterized by the complexity of the environments in which its systems operate — a complexity driven not only by extreme physical conditions, but by interactions with humans and by the need for robust performance in these settings. Many physical aerospace phenomena, such as turbulent combustion in gas turbine engines, transonic flow around transport aircraft, rarefied gas dynamics and ablation processes in atmospheric reentry, and countless more, that are essential to aerospace systems are both inaccessible in the laboratory and analytically intractable. Since the earliest days of computational fluid dynamics and computational mechanics, enormous efforts have been devoted to the development of predictive computational models of these complex processes.

II. COURSE OBJECTIVES:

The course should enable the students to:

I. Analyze the key factors affecting vehicles configuration.
II. Understand the basic concepts of gravitational terms in the equations of motion.
III. Explain the concepts of static stability, trim static performance.
IV. Analyze dynamic performance of spacecraft with respect to non-rotating planets.

III. COURSE OUTCOMES:

After successful completion of the course, students will be able to:

CO1	**Identify** the factors affecting vehicles configuration for determining its effect on flight characteristics.	**Understand**
CO2	**Develop** the equation of motion for operation of vehicle relative to the ground and flight for rigid flight vehicles using Newton's laws.	**Apply**
CO3	**Construct** the equation of motion of launch vehicle and spacecraft for static performance, impact of stability and control for the rotating planet.	**Apply**
CO4	**Demonstrate** the perturbed longitudinal equation of motion for static and dynamic stability of rigid flight vehicles.	**Analyze**
CO5	**Inspect** the impact of stability and design of longitudinal control of flight vehicles using numerical integration method.	**Analyze**
CO6	**Examine** the gliding re-entry vehicle with respect to a rotating planet using equations of motion of launch vehicles for dynamic performance.	**Understand**

IV. SYLLABUS:

UNIT-I	THE MORPHOLOGY OF FLIGHT VEHICLES	Classes: 08

Introduction, Key factors affecting vehicles configuration, Some representative flight vehicles.

UNIT-II	EQUATIONS OF MOTION FOR RIGID FLIGHT VEHICLES AND INTRODUCTION TO VEHICLE AERODYNAMICS	Classes: 10

Equations of Motion for Rigid Flight Vehicles: Definitions, Vector and Scalar realizations of Newton's second law, The tensor of inertia, Choice of vehicle axes, Operation of the vehicle relative to the ground; flight determination, Gravitational terms in the equations of motion, The state vector.

Introduction to Vehicle Aerodynamics: Aerodynamics contributions to X, Y and M, dimensionless coefficients defined, equations of perturbed longitudinal motion.

UNIT-III	AIRCRAFT DYNAMICS AND STATIC STABILITY, TRIM STATIC PERFORMANCE AND RELATED SUBJECTS	Classes: 10

Aircraft Dynamics: Equations of Motion of Aircraft including forces and moments of control surfaces, Dynamics of control surfaces.

Static Stability, Trim Static Performance and Related Subjects: Impact of stability requirements on design and longitudinal control, Static performance.

UNIT-IV	DYNAMIC PERFORMANCE OF SPACECRAFT WITH RESPECT TO NON-ROTATING PLANETS	Classes: 09

Introduction, Numerical integration of ordinary differential equations, Simplified treatment of boost from anon-rotating planet, An elementary look at staging, Equations of boost from a rotating planet.

UNIT-V	DYNAMIC PERFORMANCE OF SPACECRAFT AND DYNAMIC PERFORMANCE-ATMOSPHERIC ENTRY	Classes: 08

Dynamic Performance of Spacecraft: Equations of Motion of Launch Vehicles with respect to a rotating planet, Motion of Spacecraft with respect to a rotating planet. Dynamic Performance-Atmospheric Entry: Equation of motion, Approximate analysis of gliding entry into a planetary atmosphere.

Text Books :

1. Holt Ashley, "Engineering Analysis of Flight Vehicles", Dover Publications, 1992.

Reference Books:

1. J. D. Anderson, "Fundamentals of Aerodynamics", McGraw-Hill, 5th Edition, 2001.
2. J. J. Bertin, R. M Cummings, "Aerodynamics for Engineers", Pearson, 5th Edition, 2009.
3. Argyris G. Panaras, "Aerodynamic Principles of Flight Vehicles", AIAA Inc, 1st Edition, 2012.

Web References:

1. https://mitpress.mit.edu/books/flight-vehicle-aerodynamics
2. https://www.edx.org/course/flight-vehicle-aerodynamics-mitx-16-110x-0
3. https://www.mooc-list.com/course/16110x-flight-vehicle-aerodynamics-edx?static=true

E-Text Books:

1. http://www.freeengineeringbooks.com/AeroSpace/Aerodynamics-Books.php
2. http://www.booksamillion.com/p/Flight-Vehicle-Aerodynamics/Mark-Drela/Q685536838
3. https://www.overdrive.com/media/1553992/flight-vehicle-aerodynamics

MISSILE GUIDANCE AND CONTROL

II Semester: AE

Course Code	Category	Hours / Week			Credits	Maximum Marks		
		L	T	P	C	CIA	SEE	Total
BAEB13	Elective	3	-	-	3	30	70	100
Contact Classes: 45	Tutorial Classes: Nil	Practical Classes: Nil			Total Classes: 45			

I. COURSE OVERVIEW:

Missile guidance refers to a variety of methods of guiding a missile or a guided bomb to its intended target. The missile's target accuracy is a critical factor for its effectiveness. Guidance systems improve missile accuracy by improving its Probability of Guidance. These guidance technologies can generally be divided up into a number of categories, with the broadest categories being "active," "passive" and "preset" guidance. This course deals with the introduction to missile system, airframe, autopilots and the guidance laws. Also deals with strategic missile systems used for the warfare and automatic delivery systems of the modern missiles and aircrafts.

II. COURSE OBJECTIVES:

The course should enable the students to:

I. Understand the advanced concepts of missile guidance and control.
II. Exposure on missile systems, missile airframes, autopilots, guidance laws.
III. Deploy these skills effectively in the understanding of missile guidance and control.

III. COURSE OUTCOMES:

After successful completion of the course, students will be able to:

CO 1	**Understand** the historical background of the development of the missile guidance system	**Understand**
CO 2	**Apply** the knowledge of the Equations of motions to solve the missile trajectory characteristics	**Apply**
CO 3	**Apply** the basic principles of Autopilot systems used in missile guidance and its types	**Apply**
CO 4	**Demonstrate** the guidance laws and techniques of guidance systems and navigation system	**Understand**
CO 5	**Apply** the concept of Lamberts theorem, on missile guidance and accuracy in strategic missile	**Apply**
CO 6	**Analyze** the weapon delivery systems with guided and unguided weapon systems	**Analyze**

SYLLABUS:

UNIT-I	MISSILE SYSTEMS INTRODUCTION	Classes: 08

History of guided missile for defence applications, classification of missiles, the generalized missile equations of motion coordinate Systems, Lagrange‟s equations of or rotating coordinate systems rigid-body equations of motion missile system elements, missile ground systems.

UNIT-II	MISSILE AIRFRAMES, AUTOPILOTS AND CONTROL	Classes: 10

Missile aerodynamics: Force equations, moment equations, phases of missile flight; Missile control configurations; Missile mathematical model; Autopilots: Definitions, types of autopilots, example applications, open-loop autopilots; Inertial instruments and feedback; Autopilot response, stability and agility-pitch autopilot design, pitch-yaw-roll autopilot design.

UNIT-III	MISSILE GUIDANCE LAWS	Classes: 10

Tactical guidance intercept techniques, derivation of the fundamental guidance equations, explicit, proportional navigation, augmented proportional navigation, beam riding, bank to turn missile guidance.

Three-dimensional proportional navigation, comparison of guidance system performance, application of optimal control of linear feedback systems.

UNIT-IV	STRATEGIC MISSILES	Classes: 09

Introduction, the two-body problem, Lambert's theorem, first order motion of a ballistic missile , correlated velocity and velocity-to-be-gained concepts, derivation of the force equation for ballistic missiles, atmospheric re-entry, ballistic missile intercept, missile tracking equations of motion, introduction to cruise missiles , the terrain contour matching concept.

UNIT-V	WEAPON DELIVERY SYSTEMS	Classes: 08

Weapon delivery requirements, factors influencing weapon delivery accuracy, unguided weapons, the bombing problem, guided weapons, integrated flight control in weapon delivery, missile launch envelope and mathematical considerations pertaining to the accuracy of weapon delivery computations.

Text Books :

1. G.M. Siouris, "Missile Guidance and control systems", Springer, 2003.
2. J. H. Blakelock, Automatic Control of Aircraft and Missiles, John Wiley & Sons, 2nd Edition, 1990.
3. Eugene L. Fleeman, Tactical Missile Design, AIAA Education series, 1st Edition, 2001.

Reference Books:

1. P. Garnell, "Guided Weapon Control Systems", Pergamon Press, 2nd Edition1980.
2. Joseph Ben Asher, Isaac Yaesh “Advances in Missile Guidance Theory” AIAA Education series, 1998.
3. Paul Zarchan, “Tactical and Strategic Missile Guidance” AIAA Education series, 2007.

Web References:

1.http://www.sciencedirect.com/science/article/pii/S1000936108600217https://www.academia.edu/8521 925/Atmospheric_re-entry_vehicle_mechanics
2. http://link.springer.com/article/10.1007/s11633-010-0563-z
3. http://as.wiley.com/WileyCDA/WileyTitle/productCd-0471506516.html

E-Text Books:

1. http://read.pudn.com/downloads165/doc/project/753314/Missile%20Guidance%20and%20Control%20Syste ms.pdf
2. http://rahauav.com/Library/Stability-Control/Aircraft%20&%20Missile%20BLAKELOCK.pdf
3. https://info.aiaa.org/Regions/SE/CF/Meeting%20Minutes/AIAA%20Distinguished%20Lectur e- Missile%20Design%20and%20System%20Engineering-24%20Slides.pdf

ROCKETS AND MISSILES

II Semester: AE

Course Code	Category	Hours / Week			Credits	Maximum Marks		
		L	T	P	C	CIA	SEE	Total
BAEB14	Elective	3	-	-	3	30	70	100
Contact Classes: 45	Tutorial Classes: Nil	Practical Classes: Nil			Total Classes: 45			

I. COURSE OVERVIEW:

This course deals in detail about rockets propulsion systems. This course includes various equation of motion and various moments of a rocket. It compares and contrasts various thrust vector control mechanisms of nozzle and cooling systems of combustion chamber. It discusses on various materials and its properties that are used for manufacturing of rocket and missiles. This course also covers the basic concepts of guidance of missile and various types of tactical guidance systems and techniques.

II. COURSE OBJECTIVES:

The course should enable the students to:

I. Understand the basics of rocket and missiles, their constructions and functions.
II. Understand the combustion and propulsion systems in rockets.
III. Analyze the various aerodynamic forces and moments.
IV. Select suitable materials for the rockets and missiles.

III. COURSE OUTCOMES:

After successful completion of the course, students will be able to:

CO1	**Apply** the knowledge of combustion systems and feed systems of rockets for selecting the suitable component based on the mission requirement.	**Understand**
CO2	**Utilize** the knowledge of aerodynamic forces and moments of Rockets and missiles for designing with optimum performance.	**Apply**
CO3	**Apply** the concepts of 1-D, 2-D rocket motions in free space and gravitational fields for solving the problems in space.	**Analyze**
CO4	**Analyze** the combinations of trajectories, range, altitude and velocity of rockets and missiles for specific application.	**Apply**
CO5	**Categorize** the staging and controls of planned rocket and missiles for providing sufficient capability such as speed, range, and maneuverability.	**Apply**
CO6	**Make use of** the selection criteria of materials properties for designing new components under adverse conditions.	**Understand**

IV. SYLLABUS:

UNIT-I	**ROCKET SYSTEMS**	**Classes: 08**

Ignition system in rockets, types of igniters, igniter design considerations; Design consideration of liquid rocket combustion chamber, injector propellant feed lines, valves, propellant tanks and their outlets; Pressurized and turbine feed systems; Propellant slosh and propellant hammer; Elimination of geysering effect in missiles; Combustion system of solid rockets.

UNIT-II	**AERODYNAMICS OF ROCKET AND MISSILES**	**Classes: 10**

Airframe components of rockets and missiles; Forces acting on a missile while passing through atmosphere; Classification of missiles; Method of describing aerodynamic forces and moments; Lateral aerodynamic moment; Lateral damping moment and longitudinal moment of a rocket; Lift and drag forces; Drag estimation; Body upwash and downwash in missiles; Rocket dispersion; Numerical problems.

UNIT-III	ROCKET MOTION IN FREE SPACE AND GRAVITATIONAL FIELD	Classes: 10

One dimensional and two-dimensional rocket motions in free space and homogeneous gravitational fields; Description of vertical, inclined and gravity turn trajectories.

Determination of range and altitude; Simple approximations to burnout velocity.

UNIT-IV	STAGING AND CONTROL OF ROCKET AND MISSILES	Classes: 09

Rocket vector control, methods, thrust termination; Secondary injection thrust vector control system; Multistage of rockets; Vehicle optimization; Stage separation dynamics; Separation techniques.

UNIT-V	MATERIALS FOR ROCKET AND MISSILES	Classes: 08

Selection of materials; Special requirements of materials to perform under adverse conditions.

Text Books :

1. P. Sutton, O. Biblarz, "Rocket Propulsion Elements", John Wiley & Sons Inc., New York, 8th Edition, 2010.
2. M. J. L. Turner, "Rocket and Spacecraft propulsion", Praxis publishing, 2nd Edition, 2006.
3. M. Mathur, R. P. Sharma, "Gas Turbines and Jet and Rocket Propulsion", Standard Publishers, New Delhi, 4th Edition, 2005.

Reference Books:

1. J.W. Cornelisse H.F.R. Schoyer& K.F. Wakker "Rocket Propulsion and Space Dynamics" , pitman publications, London, 1st Edition,1979.
2. E. R. Parket, "Materials for Missiles and Spacecraft", McGraw Hill Book Co., 2nd Edition, 1982.
3. Gordon C. Oates "Aerothermodynamics of Gas Turbine Rocket Propulsion" American Institute of Aeronautics and Astronautics, Inc. 3rd Edition, 1997.

Web References:

1. http://as.wiley.com/WileyCDA/WileyTitle/productCd-0470080248.html
2. https://archive.org/details/RocketPropulsionAndSpaceflightDynamics
3. http://rapidshare.com/files/163497637/The_Jet_Engine.rar
4. http://www.personal.utulsa.edu/~kenneth-weston/chapter5.pdf

E-Text Books:

1. http://www.ewp.rpi.edu/hartford/~ernesto/S2013/EP/MaterialsforStudents/Lee/Sutton-Biblarz-Rocket_Propulsion_Elements.pdf
2. https://archive.org/details/RocketPropulsionAndSpaceflightDynamics
3. http://www.pyrobin.com/files/rocket%20and%20spacecraft%20propulsion%203540221905_1.pdf

GROUND VEHICLE AERODYNAMICS

II Semester: AE

Course Code	Category	Hours / Week			Credits	Maximum Marks		
		L	T	P	C	CIA	SEE	Total
BAEB15	Elective	3	-	-	3	30	70	100
Contact Classes: 45	Tutorial Classes: Nil	Practical Classes: Nil				Total Classes: 45		

I. COURSE OVERVIEW:

This subject deals with automotive Aerodynamics is the study of air flows around and through the vehicle body. More generally, it can be labelled "Fluid Dynamics" because air is really just a very thin type of fluid. Above slow speeds, the air flow around and through a vehicle begins to have a more pronounced effect on the acceleration, top speed, fuel efficiency and handling. Influence of flow characteristics and improvement of flow past vehicle bodies to reduction of fuel consumption, more favorable comfort characteristics (mud deposition on body, noise, ventilating and cooling of passenger compartment) and improvement of driving characteristics (stability, handling, traffic safety)

II. COURSE OBJECTIVES:

The course should enable the students to:

I. Understand the basics of vehicle aerodynamics, history of developments and apply the concepts of fluid mechanics to automobiles.
II. Estimate the drag on ground vehicles and analyze the effects of various configurations of cars on drag.
III. Analyze the stability and handling qualities based of ground vehicles due to side wind loads and dirt accumulation.
IV. Apply the above concepts to race car design and understand various experimental techniques applied in automotive aerodynamics.

III. COURSE OUTCOMES:

After successful completion of the course, students will be able to:

CO 1	**Apply** the knowledge of fluid mechanics, and aerodynamics for designing a frontal portion of a vehicle.	**Apply**
CO 2	**Analyze** the lateral stability problems of vehicle to improve the vehicle dynamics under different conditions.	**Analyze**
CO 3	**Apply** the knowledge of mechanisms, and measurement techniques for the stability of ground vehicle	**Apply**
CO 4	**Apply** the knowledge of flow behavior over different components of race vehicle for designing a race car	**Apply**
CO 5	**Apply** the knowledge of wind tunnel test for optimizing the ground vehicle design.	**Apply**
CO 6	**Apply** the knowledge of measuring equipment and transducers to investigate the roadside performance of vehicle.	**Apply**

IV. SYLLABUS:

UNIT-I	OVERVIEW AND INTRODUCTION	Classes: 10

Historical developments and trends, fundamentals of fluid mechanics, flow phenomenon related to vehicles, external and internal flow problem, resistance to vehicle motion, mechanics of air flow around a vehicle, pressure distribution, aerodynamic forces, vehicle drag and types, side and lift forces, performance potential of vehicle aerodynamics.

UNIT-II	AERODYNAMIC DRAG AND SHAPE OPTMIZATION OF CARS	Classes: 10
Cars as a bluff body, flow field around a car, analysis of aerodynamic drag, drag coefficient of cars, strategies for aerodynamic development, low drag profiles. Front end modification, front and rear wind shield angle, boat tailing, hatch back, fast back and square back, dust flow patterns at the rear, effect of rear configuration, effect of fasteners		
UNIT-III	**VEHICLE HANDLING AND STABILITY**	**Classes: 09**
Origin, characteristics and effects of forces and moments on a vehicle, lateral stability problems. Vehicle dynamics under side winds, dirt accumulation on the vehicle, wind noise: Mechanisms and generation design features, measurement and techniques.		
UNIT-IV	**RACE CAR AERODYNAMICS**	**Classes: 08**
Basic vehicle body concepts, aerodynamics of the complete vehicle, flow over wheels, sliding seal and skirts, under body channels, simple add on: spoilers, strakes and wickers, internal flow, race car wings, most current examples in detail design.		
UNIT-V	**MEASUREMENT AND TEST TECHNIQUES**	**Classes: 08**
Wind tunnel scope, fundamental techniques, simulation limitations, prototype tests, wind tunnel types and testing methods, test techniques: scope, measuring equipment and transducers, road testing methods.		

Text Books:

1. Wolf- Heinrich Hucho, "Aerodynamics of Road Vehicles", SAE International 1998.
2. Joseph Katz, "Race Car Aerodynamics Designing for Speed", Bentley Publishers, 2nd Edition, 1996.

Reference Books:

1. Alan Pope, "Wind Tunnel Testing", John Wiley & Sons, 2nd Edition, 1974.

Web References:

1. https://www.buildyourownracecar.com/race-car-aerodynamics-basics-and-design/
2. https://www.ara.bme.hu/oktatas/letolt/Vehicleaerodyn/Vehicleaerodyn.pdf
3. https://auto.howstuffworks.com/fuel-efficiency/fuel-economy/aerodynamics.html
4. https://www.slideshare.net/friendsrtg/vehicle-body-engineering-aerodynamics

E-Text Books:

1. https://dlx.bookzz.org/genesis/1111000/58a5c1c372f8f523a0c58e26c3c531eb/_as/[Wolf-Heinrich_Hucho_(Eds.)]_Aerodynamics_of_Road_(BookZZ.org).pdf
2. https://dlx.bookzz.org/genesis/555000/2c09a10c7a7c0f3deaeeb9ddc4251c26/_as/[Joseph_Katz]_Race_Car_Aerodynamics_Designing_for(BookZZ.org).pdf

ATMOSPHERIC REENTRY VEHICLE MECHANISM

II Semester: **AE**

Course Code	Category	Hours / Week			Credits	Maximum Marks		
		L	T	P	C	CIA	SEE	Total
BAEB16	**Elective**	3	-	-	3	30	70	100
Contact Classes: 45	**Tutorial Classes: Nil**	**Practical Classes: Nil**				**Total Classes: 45**		

I. COURSE OVERVIEW:

This course deals with fundamental aspects of an anatomy of re-entry module and the current trends in airframe design. It includes the evolution of the re-entry module in space industry, aerodynamics and performance of the module with their applications. It compares and contrasts various thrust vector control mechanisms of different types of atmospheric re-entry. It discusses various materials and its properties that are used for manufacturing different parts of re-entry module. This course enriches the knowledge of connection between theoretical and practical methods for performing re-entry in atmosphere.

II. COURSE OBJECTIVES:

The course should enable the students to:

I. Understand the basic mechanism of reentry vehicle.
II. Define aerodynamic principles and flight dynamics.
III. Solve the equations of motion for reentry vehicles.

III. COURSE OUTCOMES:

After successful completion of the course, students will be able to:

CO 1	**Understand** the theoretical knowledge behind the design and development of re-entry module and distinguishes them based on the mission requirements.	**Understand**
CO 2	**Apply** Newton's law of motion to determine the governing equations for interpreting the physics of flow over a re-entry module.	**Apply**
CO 3	**Identify and obtain** values of performance parameters of a re-entry module based on the aerodynamic forces and moments acting on the body at different practical scenarios.	**Apply**
CO 4	**Describe** the properties of an international standard atmosphere for identifying the suitable re-entry module to fly for different practical scenarios such as conventional transport, human space flight missions etc.	**Apply**
CO 5	**Explain** the different types of stability techniques and their usage in real world applications by understanding its limitations and safety measures.	**Apply**
CO 6	**Explain** different material properties and their usage in different segments of re-entry module	**Apply**

IV. SYLLABUS:

UNIT-I	**OVERVIEW AND INTRODUCTION**	**Classes: 08**

Classical point mass mechanics, mechanics of rigid bodies, topography and gravitation, the geodetic frame of reference, the terrestrial field of gravitation, models of atmosphere, main parameters and hypotheses, the isothermal exponential model, standard models of earth‟s atmosphere, martian models.

UNIT-II	AERODYNAMICS	Classes: 10
Aerodynamic coefficients, modes of flow, continuous mode, rare field mode, qualities of flight, characteristics of a family of sphere cones, planetary entry capsule.		
UNIT-III	**SPECIAL TREATMENT FOR REENTRY VEHICLE**	**Classes: 10**
Inertial Models: Moments of inertia, cg offset and principal axis misalignment; Changing of Reference Frame: Direction cosine matrices, Euler angles, representations with four parameters; Exo atmospheric phase: Movement of the center of mass, movement around mass center.		
UNIT-IV	**EQUATIONS OF MOTION**	**Classes: 09**
Six degree-of-freedom reentry: General equations of motion, solutions of general equations, zero angle of attacker entry; Allen's reentry results, influence of ballistic coefficient and flight path angle, influence of range; Decay of initial incidence: Zero spin rate, nonzero spin.		
UNIT-V	**FLIGHT DYNAMICS OF REENTRY VEHICLE**	**Classes: 08**
End of the convergence of the incidence: Linear equations, instantaneous angular movement, real angular motion; Roll-lock-in Phenomenon: Association of aerodynamic asymmetry and cg offset, isolated center of gravity, isolated principal axis misalignment, combined cg offset and principal axis misalignment, instabilities: static instabilities, dynamic instabilities; Reentry errors: Zeroangle-of-attack dispersions, nonzero angle of attack.		

Text Books :

1. Patrick Gallais, "Atmospheric Re-Entry Vehicle Mechanics", Springer, 1st Edition, 2007.
2. W. Hankey, "Re-Entry Aerodynamics", AIAA Education series, 1st Edition, 1988.
3. Frank J. Regan "Dynamics of Atmospheric Re-Entry" American institute of astronautics and aeronautics publications, 1st Edition, 1993.

Reference Books:

1. Peter Fortes cue, "Spacecraft Systems Engineering" Wiley, 4th Edition,1992.
2. Vladimir A. Chobotov," Orbital Mechanics" AIAA Education series, 3rd Edition, 2002.

Web References:

1. http://spacecraft.ssl.umd.edu/academics/791S04/791S04.040302.text.pdf

E-Text Books:

1. http://download.e-bookshelf.de/download/0000/0122/72/L-G-0000012272-0002345666.pdf
2. http://www.spaceatdia.org/uploads/mariano/ss1/Spacecraft%20Systems%20Engineering.pdf

HYPERSONIC AND HIGH-TEMPERATURE GAS DYNAMICS

II Semester: AE

Course Code	Category	Hours / Week			Credits	Maximum Marks		
		L	T	P	C	CIA	SEE	Total
BAEB17	Elective	3	-	-	3	30	70	100
Contact Classes: 45	Tutorial Classes: Nil	Practical Classes: Nil				Total Classes: 45		

I. COURSE OVERVIEW:

This particular course has been deigned to cover aerodynamic features of hypersonic flows with their basic governing equations and their applications in various flow fields. It also provides a comprehensive training experience in the basic principles, technologies and methodologies pertaining to the multi-disciplined realm of hypersonic flight. Participants will acquire a sound understanding of hypersonic aero physics and the effects of the hypersonic flight environment on vehicle loads and performance, including a consideration of both continuum flow and rarefied flow aerodynamic effects.

II. COUSRE OBJECTIVES:

The course should enable the students to:

I. Provide a fundamental description of hypersonic flow phenomena, including aerodynamic heating and non-equilibrium real-gas effects.
II. Explain the fundamental features of hypersonic flows, and how these differ from other flows.
III. Infer the importance and influence of non-equilibrium real-gas effects in high temperature flows.
IV. Illustrate the physical mechanisms causing aerodynamic heating of high-speed vehicles.

III. COURSE OUTCOMES:

After successful completion of the course, students will be able to:

CO 1	**Summarize** the fundamental aspect of hypersonic flow and their characteristics for solving the hypersonic flow over arbitrary shape.	**Understand**
CO 2	**Construct** the equation for variation flow properties for shock and expansion waves in hypersonic flow.	**Apply**
CO 3	**Make a use of** equivalence principle and various theories to model shock interaction in hypersonic flow field.	**Apply**
CO 4	**Build** the governing equation for viscous hypersonic laminar and turbulent boundary layer.	**Apply**
CO 5	**Select** suitable computational fluid dynamic model to solve hypersonic viscous flow.	**Apply**
CO 6	**Construct** the governing equation for high temperature inviscid equilibrium and non-equilibrium flow over an arbitrary body.	**Apply**

IV. SYLLABUS:

UNIT-I	OVERVIEW AND INTRODUCTION	Classes: 08

Hypersonic flight: Some historical firsts; Hypersonic flow: why is it important, what is it; Fundamental sources of aerodynamic force and aerodynamic heating; Hypersonic flight paths: velocity-altitude map; Hypersonic shock and expansion-wave relations: hypersonic shock and expansion-wave relations, hypersonic shock relations in terms of the hypersonic similarity parameter, hypersonic expansion-wave relations.

UNIT-II	SURFACE INCLINATION METHODS AND THEORIES	Classes: 10
Local surface inclination methods: Newtonian flow, modified Newtonian law, centrifugal force corrections to Newtonian theory, tangent-wedge tangent-cone methods, shock-expansion method; Hypersonic inviscid flow fields: Approximate methods: Governing equations, Mach-number independence, hypersonic small- disturbance equations, hypersonic similarity; Hypersonic small-disturbance theory: Some results, hypersonic equivalence principle and blast-wave theory, thin shock-layer theory; Hypersonic inviscid flow fields: Exact methods: method of characteristics, time-marching finite difference method, correlations for hypersonic shock- wave shapes, shock–shock interactions, space-marching finite difference method.		
UNIT-III	**VISCOUS FLOW AND HYPERSONIC VISCOUS INTERACTIONS**	**Classes: 10**
Viscous flow: Basic aspects boundary layer results and aerodynamic heating: Governing equations for viscous flow: Navier–stokes equations, boundary-layer equations for hypersonic flow, hypersonic boundary-layer theory, non-similar hypersonic boundary layers, hypersonic transition, hypersonic turbulent boundary layer, reference temperature method. Hypersonic viscous interactions: Strong and weak viscous interactions, role of x in hypersonic viscous interaction, hypersonic shock-wave/boundary-layer interactions, computational-fluid-dynamic solutions of hypersonic viscous flows, viscous shock-layer technique, Parabolized Navier–stokes solutions, fullnavier–stokes solutions.		
UNIT-IV	**HIGH-TEMPERATURE GAS DYNAMICS**	**Classes: 09**
Importance of high-temperature flows, nature of high-temperature flows; Chemical effects in air: The velocity-altitude map; Elements of kinetic theory: Perfect-gas equation of state, collision frequency and mean free path, velocity and speed distribution functions, definition of transport phenomena, transport coefficients, mechanism of diffusion, energy transport by thermal conduction and diffusion, transport properties for high-temperature air.		
UNIT-V	**INVISCID HIGH-TEMPERATURE EQUILIBRIUM FLOWS AND NONEQUILIBRIUM FLOWS**	**Classes: 08**
Governing equations for inviscid high-temperature equilibrium flow, equilibrium normal and oblique shock-wave flows, equilibrium quasi-one-dimensional nozzle flows, frozen and equilibrium flows, equilibrium and frozen specific heats, equilibrium speed of sound, equilibrium conical flow, equilibrium blunt-body flows, governing equations for inviscid, non-equilibrium flows, non-equilibrium normal and oblique shock-wave flows, non-equilibrium quasi-one-dimensional nozzle flows, non-equilibrium blunt- body flows, binary scaling, non-equilibrium flow over other shapes: non-equilibrium method of characteristics.		

Text Books :

1. John D. Anderson, "Hypersonic and High Temperature Gas Dynamics", McGraw Hill, 2nd Edition, 1989.
2. John J. Berlin, "Hypersonic Aerodynamics" AIAA Education series, 1st Edition, 1994.

Reference Books:

1. W. D. Hayes, Ronalds F. Probstein, "Hypersonic Flow Theory" Academic Press, 1st Edition, 1959.
2. H. W. Liepman, A. Roshko, "Elements of Gas Dynamics" John Wiley and Sons Inc., 4th Edition, 2002.

Web References:

1.http://www.southampton.ac.uk/engineering/undergraduate/UNITs/sesa6074_hypersonic_and_high_temperature_gas_dynamics.page#aims_and_objectives

E-Text Books:

1. https://www.scribd.com/doc/248036966/Anderson-Hypersonic-and-High-Temperature-Gas-Dynamics

TURBO MACHINERY AND DYNAMICS

II Semester: AE

Course Code	Category	Hours / Week			Credits	Maximum Marks		
		L	T	P	C	CIA	SEE	Total
BAEB18	Elective	3	-	-	3	30	70	100
Contact Classes: 45	Tutorial Classes: Nil	Practical Classes: Nil			Total Classes: 45			

I. COURSE OVERVIEW:

This course provides an introduction to the working principles, performance and design of turbo machinery. The course first covers a review of essential fluid and thermo-dynamics. Concepts relevant to all turbo machines are then introduced. Axial turbines and compressors are studied in depth, including their kinematics, performance and design. The three-dimensional effects in turbo machinery, centrifugal machines, propellers, hydraulic turbines and wind turbines.

II. COURSE OBJECTIVES:

The course should enable the students to:

I. The working principles of turbines and pumps/compressors
II. The basic loading and performance analysis for a variety of machines
III. The fluid-thermodynamic mechanisms associated with performance degradation
IV. The basic operating principles of centrifugal machines, propellers, hydraulic turbines and wind turbines

III. COURSE OUTCOMES:

After successful completion of the course, students will be able to:

CO 1	**Relate** the working principles of turbo machines for predicting its thermodynamic.	**Analyze**
CO 2	**Demonstrate** typical designs of turbo machines and differentiate from positive displacement machines.	**Understand**
CO 3	**Illustrate** the off-design behavior of turbines and compressors and relate it to changes in the velocity triangles.	**Apply**
CO 4	**Analyze** the relations between choices made early in the turbo machinery design process and the final components and operability.	**Analyze**
CO 5	**Apply** the Euler's equations for turbomachinery to analyze energy transfer in turbomachines	**Apply**
CO 6	**Analyze** the performance of turbo machinery by using the preliminary designs of pumps, compressors and turbines.	**Analyze**

IV. SYLLABUS:

UNIT-I	ENERGY TRANSFER IN TURBO MACHINES	Classes: 08

Application of first and second laws of thermodynamics to turbo machines, moment of momentum equation and Euler turbine equation, principles of impulse and reaction machines, degree of reaction, energy equation for relative velocities, one dimensional analysis only.

UNIT-II	STEAM TURBINES	Classes: 10
Impulse staging, velocity and pressure compounding, utilization factor, analysis for optimum U.F curtis stage, and rate au stage, include qualitative analysis, effect of blade and nozzle losses on vane efficiency, stage efficiency and analysis for optimum efficiency, mass flow and blade height; Reactions staging: Parson‟s stages, degree of reaction, nozzle efficiency, velocity coefficient, stator efficiency, carry over efficiency, stage efficiency, vane efficiency, conditions for optimum efficiency, speed ratio, axial thrust, reheat factor in turbines, problem of radial equilibrium, free and forced vortex types of flow, flow with constant reaction, governing and performance characteristics of steam turbines.		
UNIT-III	**WATER TURBINES**	**Classes: 10**
Classification, Pelton, Francis and Kaplan turbines, vector diagrams and work-done, draft tubes, governing of water turbines; Centrifugal pumps: classification, advantage over reciprocating type, definition of mano-metric head, gross head, static head, vector diagram and work done. Performance and characteristics: Application of dimensional analysis and similarity to water turbines and centrifugal pumps, unit and specific quantities, selection of machines, hydraulic, volumetric, mechanical and overall efficiencies, Main and operating characteristics of the machines, cavitations.		
UNIT-IV	**ROTARY FANS, BLOWERS AND COMPRESSORS**	**Classes: 09**
Classification based on pressure rise, centrifugal and axial flow machines; Centrifugal Blowers Vane shape, velocity triangle, degree of reactions, slip coefficient, size and speed of machine, vane shape and stresses, efficiency, characteristics, fan laws and characteristics; Centrifugal Compressor – Vector diagrams, work done, temp and pressure ratio, slip factor, work input factor, pressure coefficient, Dimensions of inlet eye, impeller and diffuser; Axial flow compressors; Vector diagrams, work done factor, temp and pressure ratio, degree of reaction, dimensional analysis, characteristics, surging, polytrophic and isentropic efficiencies.		
UNIT-V	**POWER TRANSMITTING TURBO MACHINES**	**Classes: 08**
Application and general theory, their torque ratio, speed ratio, slip and efficiency, velocity diagrams, fluid coupling and Torque converter, characteristics, positive displacement machines and turbo machines, their distinction; Positive displacement pumps with fixed and variable displacements, hydrostatic systems hydraulic intensifier, accumulator, press and crane.		

Text Books :

1. Yahya S.H., Turbines, “Compressor and Fans”, TMH, 2nd Edition, 2008.
2. Venkanna B. K., “Fundamentals of Turbomachines”, PHI Learning Private Limited, 5th Edition, 2005.

Reference Books:

1. Kadambi V Manohar Prasad; “An introduction to EC Turbomachinery” Vol.III, Wiley Eastern, 1st Edition, 1999.

Web References:

1. http://www.slideshare.net/asifzhcet/fluid-mechanics-and-hydraulic-machines-dr-r-k-bansal
2. http://as.wiley.com/WileyCDA/WileyTitle/productCd-0470124229.html

E-Text Books:

1. http://files.asme.org/Divisions/FED/16300.pdf
2. ftp://210.212.172.242/Digital_Library/Mechanical/TURBOMACHINES/Principles%20of%20Turbomachinery.pdf

FLIGHT SIMULATION AND CONTROLS LABORATORY

II Semester: AE

Course Code	Category	Hours / Week			Credits	Maximum Marks		
		L	T	P	C	CIA	SEE	Total
BAEB19	Core	-	-	4	2	30	70	100
Contact Classes: Nil	Tutorial Classes: Nil	Practical Classes: 48				Total Classes: 36		

I. COURSE OVERVIEW:

Flight simulation and Control is the science that investigates the stability and control of aircrafts and all other flying vehicles. From the advent of the first flight by the Wright Brothers, it was observed that flight without knowledge of stability and control was not viable. Since then, several different concepts for controlling aircraft flight have been devised including control surfaces, deformable surfaces, morphing of wings etc. This course introduces some of these concepts and describes their operation, as well as the degree of stability that these devices can provide. Modern aircraft control is ensured through automatic control systems known as autopilot. Their role is to increase safety, facilitate the pilot's task and improve flight qualities. The course will introduce modern aircraft stability and control and discuss some of its objectives and applications

II. COURSE OBJECTIVES:

The course should enable the students to:

I. Understand the basics simulation of unaccelerated and accelerated level flight for climb and descend.

II. Analyze the takeoff and landing performance and ground roll for different modes of aircraft.

III. Identify the basic controls and maneuver of in complex flight Path.

III. COURSE OUTCOMES:

After successful completion of the course, students will be able to:

CO 1	**Choose** the appropriate flight path using flight simulator for simulating the un-accelerated and accelerated flights.	**Understand**
CO 2	**Estimate** the take-off velocity, ground roll distance, and landing distance using flight simulator for the Cessna aircraft.	**Apply**
CO 3	**Make use of** flight simulator's mission profiles for simulating the different flight maneuvers.	**Analyze**
CO 4	**Examine** the longitudinal and lateral perturbed stability of aircraft for obtaining desired operational ability.	**Apply**
CO 5	**Analyze** lateral and directional coupled dynamic stability for a given aircraft to simulate spin recovery.	**Apply**
CO 6	**Determine** turn rates, radius and barrel roll by using flight simulator for assessing flight performance in given condition.	**Analyze**

LIST OF EXPERIMENTS

Week-1 SIMULATION OF UNACCELERATED AND ACCELERATED LEVEL FLIGHT

Implement the following tasks

1. Simulation of steady flight
2. Simulation of accelerated level flight at various altitudes

Week-2	SIMULATION OF UNACCELERATED AND ACCELERATED CLIMB
Implement the following tasks 1. Simulation of steady climb 2. Simulation of accelerated climb at various climb rates	
Week-3	**SIMULATION OF UNACCELERATED AND ACCELERATED DESCENT**
Implement the following tasks 1. Simulation of steady descent 2. Simulation of accelerated descent at various descent rates	
Week-4	**SIMULATION OF TAKE-OFF PERFORMANCE**
Implement the following tasks 1 Estimation of takeoff velocity for Cessna flight.	
Week-5	**SIMULATION OF LANDING PERFORMANCE**
Implement the following tasks 1. Estimation of ground roll distance for Cessna flight 2. Estimation of total landing distance for Cessna flight	
Week-6	**SIMULATION OF CONVENTIONAL FLIGHT PATH**
Implement the following tasks 1. Perform the given mission profiles	
Week-7	**STABILIZATION OF LONGITUDINAL PERTURBED AIRCRAFT**
Implement the following tasks 1. Perform the operation from disturbed flight to trim flight	
2. Perform long period and short period modes.	
Week-8	**STABILIZATION OF LATERAL PERTURBED AIRCRAFT**
Implement the following tasks 1. Perform the operation from disturbed flight to trim flight 2. Simulate lateral directional modes.	
Week-9	**SIMULATION OF SPIN RECOVRY**
Implement the following tasks 1. Perform the operation of spin recovery	
Week-10	**SIMUILATION OF COORDINATED LEVEL TURN**
Implement the following tasks 1. Perform the level turn at given turn rate. 2. Perform the level turn at given turn radius.	
Week-11	**SIMUILATION OF BARREL ROLL MANEUVER**
Implement the following tasks 1. Perform the barrel roll maneuver	

Week-12	SIMULATION OF A COMPLEX FLIGHT PATH

Implement the following tasks

1. Perform flight simulation for given mission profiles

Reference Books:

1. Peter John Davison. "A summary of studies conducted on the effect of motion in flight simulator pilot training". 5th February 2014
2. Beard, Steven; et al. "Space Shuttle Landing and Rollout Training at the Vertical Motion Simulator" (PDF). AIAA. Retrieved 5th February 2014.

Web References:

1. www.helijah.free.fr/dev/Principles-of-Flight-Simulation.pdf/
2. www.faa.gov/news/safety_briefing/2012/media/SepOct2012ATD.pdf
3. www.aerosociety.com/Assets/Docs/Publications/DiscussionPapers/The_impact_of_flight_simulation_in_aerospace.pdf

COMPUTATIONAL STRUCTURES LABORATORY

II Semester: AE

Course Code	Category	Hours / Week			Credits	Maximum Marks		
		L	T	P	C	CIA	SEE	Total
BAEB20	Core	-	-	4	2	30	70	100
Contact Classes: Nil	Tutorial Classes: Nil	Practical Classes: 48			Total Classes: 36			

I. COURSE OVERVIEW:

The major emphasis of this course is to solve a complex geometrical structure under a given loads, these methods does not have analytical solutions. Software's like ANSYS and NASTRAN is utilized to interpret results for complex geometries. Modeling of crack and composite structures help the students to solve realistic problems which are common in industries. Structural analysis on aircraft structures and Rocket components are delt to obtain the solution for bending and torsion under the applied aerodynamic loads.

II. COURSE OBJECTIVES:

The course should enable the students to:

I. Identify the strength of ANSYS and NASTRAN software for the solution of fluid mechanics and structural mechanics problems.
II. Describe steps necessary to solve a particular problem.
III. Solve practical problems.
IV. Interpret the results obtain from ANSYS and NASTRAN software.

III. COURSE OUTCOMES:

After successful completion of the course, students will be able to:

CO 1	**Develop** the appropriate method for predicting ultimate load on wing using ANSYS.	**Analyze**
CO 2	**Estimate** the rocket motor case loading for the launch vehicle by using computational tools.	**Analyze**
CO 3	**Examine** the thermal and structural loading on exposed components during the flight mission for obtaining airworthiness suitability.	**Analyze**
CO 4	**Make use of** the structural fatigue concept for obtaining desired operational characteristics.	**Analyze**
CO 5	**Analyze** the effect of fracture during bird hit using L S Dyna simulation for failure rate of an aircraft.	**Analyze**
CO 6	**Determine** the failure mode during fracture of an aircraft component for assessing crack propagation.	**Analyze**

LIST OF EXPERIMENTS

Week-1	**AEROSPACE STRUCTURAL ANALYSIS USING ANSYS-I**

Implement the following tasks

1. Structural analysis of aircraft wing

Week-2	**AEROSPACE STRUCTURAL ANALYSIS USING ANSYS-II**
Implement the following tasks 1. Structural analysis of aircraft wing (composite material)	
Week-3	**AEROSPACE STRUCTURAL ANALYSIS USING ANSYS-III**
Implement the following tasks 1. Analysis of fuselage	
Week-4	**AEROSPACE STRUCTURAL ANALYSIS USING ANSYS-IV**
Implement the following tasks 1. Rocket motor case analysis	
Week-5	**AEROSPACE STRUCTURAL ANALYSIS USING ANSYS-V**
Implement the following tasks 1. Structural and thermal analysis of rocket nozzles	
Week-6	**AEROSPACE STRUCTURAL ANALYSIS USING ANSYS-VI**
Implement the following tasks 1. Fractural mechanics of crack propagation	
Week-7	**AEROSPACE STRUCTURAL ANALYSIS USING NASTRA-I**
Implement the following tasks 1. Structural analysis of aircraft wing	
Week-8	**AEROSPACE STRUCTURAL ANALYSIS USING NASTRA-II**
Implement the following tasks 1. Structural analysis of aircraft wing (composite material)	
Week-9	**AEROSPACE STRUCTURAL ANALYSIS USING NASTRA-III**
Implement the following tasks 1. Analysis of fuselage	
Week-10	**AEROSPACE STRUCTURAL ANALYSIS USING NASTRA-IV**
Implement the following tasks 1. Rocket motor case analysis	
Week-11	**AEROSPACE STRUCTURAL ANALYSIS USING NASTRA-V**
Implement the following tasks 1. Structural and thermal analysis of rocketnozzles	
Week-12	**AEROSPACE STRUCTURAL ANALYSIS USING NASTRA-VI**

Implement the following tasks

1. Fractural mechanics of crackpropagation

Reference Books:

1. Y. Nakasone, S.Yoshimoto, T.A. Stolarski, "Engineering analysis with ANSYS software", Elsevier Publication,2006.
2. MSC Nastran 2014.1 Quick Reference Guide, Jun.2015.
3. John C Tannehill, Dale A Anderson, Richard H Pletcher, "Computational Fluid Mechanics And Heat Transfer", Taylor & Francis Publication , 2nd Edition,1997.
4. T J Chug, "Computational Fluid Dynamics", Cambridge University Press, 2002.

Web References:

1. http://resource.ansys.com/staticassets/ANSYS/staticassets/resourcelibrary/article/AA-V4-I1-Teaching-Simulation-to-Future-Engineers.pdf
2. http://www.autodesk.in/products/simulation/overview
3. http://www.serc.iisc.in/facilities/ansys-13-0-cfd/

RESEARCH METHODOLOGY AND IPR

III Semester: CSE, ES, CAD/CAM, AE, ST, PEED

Course Code	Category	Hours / Week			Credits	Maximum Marks		
		L	T	P	C	CIA	SEE	Total
BCSB31	Core	2	-	-	2	30	70	100
Contact Classes: 30	Tutorial Classes: Nil	Practical Classes: Nil				Total Classes: 30		

I. COURSE OVERVIEW:

This course imparts research methodology and philosophy of intellectual property rights, including basic concepts employed in quantitative and qualitative research methods, Patents, Copyrights, and Trademarks. It provides the research framework, research methodology research design, and formulation hypothesis, sampling techniques, data analysis and report writing. It implies on research skills and intellectual property rights to encourage new creations, including technology, artwork, and inventions, that might increase economic growth.

II. COURSE OBJECTIVES:

The course should enable the students to:

I. Understand research problem formulation.
II. Analyze research related information.
III. Follow research ethics.
IV. Understand that today's world is controlled by Computer, Information Technology; but tomorrow world will be ruled by ideas, concept, and creativity.

III. COURSE OUTCOMES:

After successful completion of the course, students should be able to:

CO1	**Interpret** the technique of determining a research problem for a crucial part of the research study.	**Remember**
CO2	**Examine** the way of methods for avoiding plagiarism in research.	**Apply**
CO3	**Apply** the feasibility and practicality of research methodology for a proposed project.	**Apply**
CO4	**Make use of** the legal procedure and document for claiming patent of invention.	**Understand**
CO5	**Identify** different types of intellectual properties, the right of ownership, scope of protection to create and extract value from IP.	**Understand**
CO6	**Defend** the intellectual property rights throughout the world with the involvement of world intellectual property organization	**Apply**

IV. SYLLABUS:

UNIT-I	INTRODUCTION	Classes: 07

Meaning of research problem, Sources of research problem, Criteria Characteristics of a good research problem, Errors in selecting a research problem, Scope and objectives of research problem.
Approaches of investigation of solutions for research problem, data collection, analysis, interpretation, Necessary instrumentations

UNIT-II	**RESEARCH ETHICS**	**Classes: 05**
Effective literature studies approaches, analysis Plagiarism, Research ethics.		
UNIT-III	**RESEARCH PROPOSAL**	**Classes: 06**
Effective technical writing, how to write report, Paper Developing a Research Proposal. Format of research proposal, a presentation and assessment by a review committee		
UNIT-IV	**PATENTING**	**Classes: 06**
Nature of Intellectual Property: Patents, Designs, Trade and Copyright. Process of Patenting and Development: technological research, innovation, patenting, development. International Scenario: International cooperation on Intellectual Property. Procedure for grants of patents, Patenting under PCT.		
UNIT-V	**PATENT RIGHTS**	**Classes: 06**
Patent Rights: Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications. New Developments in IPR: Administration of Patent System. New developments in IPR; IPR of Biological Systems, Computer Software etc. Traditional knowledge Case Studies, IPR and IITs.		
Text Books:		
1. Stuart Melville and Wayne Goddard, "Research methodology: an introduction for science & engineering students'" 2. Wayne Goddard and Stuart Melville, "Research Methodology: An Introduction" 3. Ranjit Kumar, 2nd Edition, "Research Methodology: A Step by Step Guide for beginners"		
Reference Books:		
1. Halbert, "Resisting Intellectual Property", Taylor & Francis Ltd , 2007. 2. Mayall , "Industrial Design", McGraw Hill, 1992.		
3. Niebel , "Product Design", McGraw Hill, 1974. 4. Asimov , "Introduction to Design", Prentice Hall, 1962.		
Web References:		
1. Robert P. Merges, Peter S. Menell, Mark A. Lemley, " Intellectual Property in NewTechnological Age", 2016 2. T. Ramappa, "Intellectual Property Rights Under WTO", S. Chand, 2008		
E-Text Books:		
1. http://nptel.ac.in/courses/107108011/		

MISSILE AERODYNAMICS

III Semester: AE

Course Code	Category	Hours / Week			Credits	Maximum Marks		
		L	T	P	C	CIA	SEE	Total
BAEB22	Elective	3	-	-	3	30	70	100
Contact Classes: 45	Tutorial Classes: Nil	Practical Classes: Nil				Total Classes: 45		

I. COURSE OVERVIEW:

The Missile Aerodynamics course is intended for the aerospace professional seeking expert instruction in the fundamentals of missile aerodynamics as applied to airframe design, analysis and test. The course provides students with a focused training experience in the aerodynamics of tactical missiles, ballistic missiles, launch vehicles, sounding rockets and projectiles. Participants will learn about vehicle 6-DOF aerodynamic force and moment models, airframe component airloads, atmospheric models, and mass property models.The course also includes a consideration of the unique aspects of projectile aerodynamics with particular emphasis on vehicle static, dynamic, and gyroscopic stability.

II. COURSE OBJECTIVES:

The course should enable the students to:

I. Explain the aerodynamic characteristics in missile.
II. Discuss the lateral and directional stability, control and maneuvering flight.
III. Understand the aerodynamic loads in missile.

III. COURSE OUTCOMES:

After successful completion of the course, students will be able to:

CO 1	**Classify** various missiles and their control for the suitable selection in real world applications.	**Understand**
CO 2	**Describe** the aerodynamic characteristics of airframe components for different missile configurations	**Understand**
CO 3	**Calculate** the performance of various missile configurations for different operational envelops	**Apply**
CO 4	**Compare** the longitudinal stability of various missiles for forward and rear control	**Analyze**
CO 5	**Choose** the appropriate wing, body and tail configuration for better directional stability	**Apply**
CO 6	**Apply** the formation of induced roll and their control for improving lateral stability of missile	**Apply**

IV. SYLLABUS:

UNIT-I	INTRODUCTION	Classes: 08

Theory of bodies of revolution; Lift and moment of slender bodies of revolution; Planar W-B interference; Classes of missiles, types of design and control; Wing, canard, tail, tailless control; Dorsal, jet control, mono wing, triform, and cruciform.

UNIT-II	AERODYNAMIC CHARACTERISTICS OF AIRFRAME COMPONENTS & MISSILE PERFORMANCE	Classes: 10
Forebody: Conical, Ogival, hemi-spherical, etc.; Midsection: Boat-tail; Characteristics of bodies of revolution; Aerodynamics of airfoil, aspect-ratio, wing plan form; Aerodynamic control: Wing, canard and tail; Missile performance: Introduction; Drag: Friction, pressure, interference, induced and boat tail drag; Boost glide trajectory: graphical and iterative method; Long range cruise trajectory; Maximum speed, rate of climb, time to climb, stall speed, maximum range; Long range ballistic trajectory: powered and unpowered flight and design consideration.		
UNIT-III	**LONGITUDINAL STABILITY AND CONTROL, MANEUVERING FLIGHT**	**Classes: 10**
Introduction, two-degree of freedom analysis, complete missile aerodynamics: static stability margin, load factor capability for forward control and rear control. Flat turn: Cruciform, triform, pull-ups; Relation between maneuverability and load factor; Stability margin.		
UNIT-IV	**DIRECTIONAL & LATERAL STABILITY AND CONTROL**	**Classes: 09**
Introduction; Cruciform configuration: wing, body and tail contribution; Directional control; Introduction to lateral stability and control; Induced roll: Cruciform, lateral control cruciform, special design consideration, damping in roll, induced roll, mono wing, lateral control, mono wing.		
UNIT-V	**AIR LOADS: DESIGN CRITERIA**	**Classes: 08**
Forward control; Rear control; Component air loads: Body, aerodynamic surfaces; Component load distribution: Body and lifting surfaces; Aerodynamic hinge moments and aerodynamic heating.		

Text Books :

1. S. S. Chin, "Missile Configuration Design", McGraw Hill, 1st Edition, 1960.
2. Jack N. Neilson, "Missile Aerodynamics", McGraw Hill, 1st Edition, 1960.

Reference Books:

1. M. J. Hemsch, J. N. Nielsen, "Tactical Missile Aerodynamics", AIAA, 2006.
2. J. H. Blacklock, "Automatic Control of Aircraft and Missiles", John Wiley & Sons, 2nd Edition, 1991.

Web References:

1. http://techdigest.jhuapl.edu/views/pdfs/V04_N3_1983/V4_N3_1983_Cronvich.pdf
2. http://www.dtic.mil/dtic/tr/fulltext/u2/a217480.pdf
3. http://ntrs.nasa.gov/archive/nasa/casi; ntrs.nasa.gov/19880020389;pdf

E-Text Books:

1. http://www.abebooks.com/Missile-Configuration-Design-CHIN-S-S/9847235911/bd
2. https://aerocastle.files.wordpress.com/2012/04/missile_configuration_desig.pdf
3. http://www.worldcat.org/title/missile-configuration-design/oclc/602683910
4. https://www.waterstonesmarketplace.com/Missile-aerodynamics-Jack-Norman-Nielsen/book/4396415

FLIGHT SIMULATION

III Semester: AE

Course Code	Category	Hours / Week			Credits	Maximum Marks		
		L	T	P	C	CIA	SEE	Total
BAEB23	Elective	3	-	-	3	30	70	100
Contact Classes: 45	Tutorial Classes: Nil	Practical Classes: Nil			Total Classes: 45			

I. COURSE OVERVIEW:

Flight simulation and Control is the science that investigates the stability and control of aircrafts and all other flying vehicles. From the advent of the first flight by the Wright Brothers, it was observed that flight without knowledge of stability and control was not viable. Since then, several different concepts for controlling aircraft flight have been devised including control surfaces, deformable surfaces, morphing of wings etc. This course introduces some of these concepts and describes their operation, as well as the degree of stability that these devices can provide. Modern aircraft control is ensured through automatic control systems known as autopilot. Their role is to increase safety, facilitate the pilot's task and improve flight qualities. The course will introduce modern aircraft stability and control and discuss some of its objectives and applications

II. COURSE OBJECTIVES:

The course should enable the students to:

I. Illustrate the history of flight simulation.
II. Understand the principle of modeling and simulation of flight control systems.
III. Describe the dynamics of aircraft and model validation.

III. COURSE OUTCOMES:

After successful completion of the course, students will be able to:

CO 1	**Recognize** the aircraft components contributing to the stability of different aircraft models like Military, Civil and transport aircrafts.	**Understand**
CO 2	**Identify** stick fixed and stick free conditions for neutral points with an appropriate static margin, control force and CG limitation.	**Apply**
CO 3	**Interpret** the specific coupling between lateral and directional static stability of the aircraft and its influence on other motion of a typical aircraft.	**Analyze**
CO 4	**Construct** the mathematical model of aircraft motion in longitudinal, lateral and directional cases for establishing the status of the flight vehicles stability.	**Apply**
CO 5	**Explain** qualitatively about motion in three-dimensions, Euler angles and rates, full 6-DOF equations for rigid symmetrical aircraft, state space formulation, and solution in the time domain and flight simulation.	**Analyze**
CO 6	**Apply** the advances of flight dynamics and controls in design of modern airplane control system.	**Apply**

IV. SYLLABUS:

UNIT-I	INTRODUCTION	Classes: 08

Historical Perspective, the first 40 years of flight 1905–1945,analogue computing, 1945–1965, digital computing 1965–1985, the microelectronics revolution, 1985 present, the case for simulation, safety, financial benefits, training transfer, engineering flight simulation, the changing role of simulation, the organization of a flight simulator, equations of motion, aerodynamic model, engine model, data acquisition, gear model, weather model, visual system, sound system, motion system, control loading, instrument displays, navigation systems, maintenance, the concept of real-time simulation, pilot cues, visual cueing, motion cueing, training versus simulation, examples of simulation, commercial flight training, military flight training, Ab initio flight training, land vehicle simulators, engineering flight simulators aptitude testing, computer-based training, maintenance training.

UNIT-II	PRINCIPLES OF MODELLING	Classes: 10

Modelling concepts, Newtonian mechanics, axes systems, differential equations, numerical integration, approximation methods, first order methods, higher order methods, real-time computing, data acquisition, data transmission, data acquisition, flight data, interpolation, distributed systems, a real-time protocol, problems in modelling,

UNIT-III	AIRCRAFT DYNAMICS	Classes: 10

Principles of flight modelling, the atmosphere, forces, aerodynamic lift, aerodynamic side force, aerodynamic drag, propulsive forces, gravitational force, moments, static stability, aerodynamic moments, aerodynamic derivatives, axes systems, the body frame, stability axes, wind axes, inertial axes, transformation between axes.

Earth-centred earth-fixed frame, latitude and longitude, quaternions, equations of motion; Propulsion, piston engines, jet engines, the landing gear, the equations collected; The equations revisited: Long range navigation, coriolis acceleration.

UNIT-IV	SIMULATION OF FLIGHT CONTROL SYSTEMS	Classes: 09

The Laplace transform, simulation of transfer functions; Proportional–integral–derivative control systems, trimming, aircraft flight control systems, the turn coordinator and the yaw damper, the auto- throttle, vertical speed management, altitude hold, heading hold, localizer tracking, auto-land systems, flight management systems.

UNIT-V	MODEL VALIDATION AND VISUAL SYSTEMS	Classes: 08

Simulator qualification and approval, model validation methods, cockpit geometry, open-loop tests, closed-loop tests, latency, performance analysis, longitudinal dynamics, lateral dynamics, model validation in perspective; Visual systems: Background, the visual system pipeline, graphics operations, real-time image generation, a rudimentary real time wire frame image generation system, an open GL real-time image generation system, an open GL real-time textured image generation system, an open scene graph image generation system, visual database management, projection systems, problems in visual systems.

Text Books :

1. David Allerton, “Principles of Flight simulation” John Wiley & Sons, Ltd Publication, 1st Edition 1999.
2. M. J Rycroft, “Flight simulation”, Cambridge university press, 1st Edition, 1999.
3. J. M. Rolfe, K. J. Staples “Flight simulation”, Cambridge University press, 1st Edition, 1987.
4. Jeffrey Strickland, “Missile Flight Simulation”, Lulu press, Inc, 2nd Edition, 2012.
5. Jonathan M. Stern “Microsoft Flight Simulator Handbook” Brady Publishing, 1st Edition, 1995.

Reference Books:

1. RanjanVepa, "Flight Dynamics, Simulation, and Control: For Rigid and Flexible Aircraft", CRC press, 1st Edition, 2014.
2. Duane Mc Ruer, Irving Ashkenas, Dunstan Graham "Aircraft Dynamics and Automatic Control" Princeton University Press, 2nd Edition, 2014.
3. Brian L. Stevens, Frank L. Lewis, "Aircraft Control and Simulation", John Wiley & Sons Ltd Publication, 2nd Edition, 2003.

Web References:

1. https://www.doc.ic.ac.uk/~nd/surprise_96/journal/vol1/kwc2/article1.html
2. http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.132.5428&rep=rep1&type=pdf
3. http://research.omicsgroup.org/index.php/Flight_simulator
4. http://as.wiley.com/WileyCDA/WileyTitle/productCd-0471371459.html

E-Text Books:

1. http://www.aeronautics.nasa.gov/pdf/principles_of_flight_in_action_9_12.pdf
2. http://helijah.free.fr/dev/Principles-of-Flight-Simulation.pdf
3. https://leseprobe.buch.de/images-adb/ee/49/ee495ffc-8dc1-4a07-ad7b-b18540b9fb60.pdf
4. http://samples.sainsburysebooks.co.uk/9780470682197_sample_388478.pdf

AIRPORT PLANNING AND OPERATION

III Semester: AE

Course Code	Category	Hours / Week			Credits	Maximum Marks		
		L	T	P	C	CIA	SEE	Total
BAEB24	Core	3	-	-	3	30	70	100
Contact Classes: 45	Tutorial Classes: Nil	Practical Classes: Nil			Total Classes: 45			

I. COURSE OVERVIEW:

The aim is to understanding of relevant international and national regulations and the ability to explain their effects on airport business, planning, design, operations and safety management decisions. A critical awareness of the key issues that affect users of airport facilities. And to identify, analyse and design solutions in order to address a given research problem within the context of airport planning and management, having regard to regulatory constraints and commercial and environmental imperatives.

II. COURSE OBJECTIVES:

The course should enable the students to:

I. Understand complexity and functioning of airport operation systems.
II. Understand many operational issues involved in handling passengers, freight and aircraft at airports.

III. COURSE OUTCOMES:

After successful completion of the course, students will be able to:

CO 1	**Identify** the airport management systems by using modern tools for assessing airport performance and safety.	**Understand**
CO 2	**Develop** the ground handling system by using organizational and managerial skills for the efficient flow of passengers and goods in an airport.	**Apply**
CO 3	**Model** the philosophies of terminal management of airline passenger services by using Hubbind's theory for ascertaining optimum flow pattern.	**Understand**
CO 4	**Organize** the cargo handling, operations, and marketing by using modern cargo terminal design concepts for expediting the movement in the airport terminal.	**Understand**
CO 5	**Make use of** airport technical services by the passengers and stake holders for the effective utilization of facilities.	**Apply**
CO 6	**Examine** the operational and administrative performance of an airport using the management techniques for effective utilization of human resources.	**Understand**

IV. SYLLABUS:

UNIT- I	THE AIRPORT AS AN OPERATIONAL SYSTEM	Classes: 08

The airport as a system; National airport systems; The function of the Airport; Centralized and decentralized passenger terminal systems; The complexity of the airport operation; Management and operational structures; Airport influences on aircraft performance characteristics: Aircraft departure performance; Approach and landing performance; Safety considerations; Automatic landing; Operations in inclement weather; Specific implications of the Airbus A380; Operational Readiness: Aerodrome certification; Operating constraints; Operational areas; Airfield Inspections; Maintaining readiness.

UNIT-II	GROUND HANDLING AND BAGGAGE HANDLING	Classes: 10
Ground handling: Passenger handling; Ramp handling; Aircraft ramp servicing; Ramp layout; Departure control; Division of ground handling responsibilities; Control of ground handling efficiency; Baggage handling: Context, history and trends; Baggage handling processes; Equipment, systems and technologies, process and system design drivers; Organization; Management and performance metrics.		
UNIT-III	**PASSENGER TERMINAL AND CARGO OPERATIONS**	**Classes: 10**
Passenger terminal operations: Functions of the passenger terminal; Terminal functions; Philosophies of terminal management; Direct passenger services; Airline related passenger services; Airline related operational functions; Government requirements; Non-passenger related airport authority functions; processing very important persons; Passenger information systems; Space components and adjacencies. Aids to circulation; Hubbind considerations; Cargo operations: The cargo market; Expediting the movement; Flow through the terminal; unit load devices; Handling within the terminal; Cargo apron operation; Facilitation; Examples of modern cargo terminal design and operation; Cargo operations by the integrated carriers.		
UNIT-IV	**AIRPORT TECHNICAL SERVICES AND ACCESS**	**Classes: 09**
Airport technical services: The scope of technical services; Safety management system; Air traffic control; Tele communications; Meteorology; Aeronautical information; Airport access: Access as part of the airport system; access users and modal choice; access interaction with passenger; access modes; In town and other off; airport terminals; Factors affecting access; mode choice.		
UNIT-V	**OPERATIONAL ADMINISTRATION AND PERFORMANCE**	**Classes: 08**
Operational administration and performance: Strategic context; Tactical approach to administration of airport operations; Managing operational performance; Key success factors for high; performance; airport operations control centers: The concept of airport operations; airport operations control system; the airport operations consideration; airport performance monitoring; design and equipment considerations; organizational and human resources considerations; leading AOCCSs; best practices in airport operations.		

Text Books :

1. Norman J. Ashford, H. P. Martin Stanton, Clifton A. Moore, Pierre Coutu, "Airport Operations", McGraw Hill, 3rd Edition, 2013.
2. R. Horonjeff, F. X. McKelvey, W. J. Sproule, S. B. Young, "Planning and Design of Airports", McGraw Hill, 5th Edition, 2010.

Reference Books:

1. A. Kazda, R. E. Caves, "Airport Design and Operation", Elsevier, 2nd Edition, 2007.
2. A. T. Wells, S. B. Young, "Airport Planning and Management", McGraw Hill, 6th Edition, 2011.

Web References:

1. http://memberfiles.freewebs.com/94/47/55224794/documents/airport%20planning%20and%20management.pdf
2. https://books.google.co.in/books?id=RYR6cu4YSBcC&dq=Planning%20and%20Design%20of%20Airports&source=gbs_similar books

E-Text Books:

1. https://accessengineeringlibrary.com/browse/airport-planning-and-management-sixth-edition
2. http://www.only4engineer.com/2014/10/planning-and-design-of-airports-by.html

BUSINESS ANALYTICS

Open Electives

Course Code	Category	Hours / Week			Credits	Maximum Marks		
		L	T	P	C	CIA	SEE	Total
BCSB25	Open Elective	3	-	-	3	30	70	100
Contact Classes: 45	Tutorial Classes: Nil	Practical Classes: Nil				Total Classes: 45		

I. COURSE OVERVIEW:

This course covers the fundamentals of data analysis, such as data gathering or data mining .this course covers concepts of data analysis, regression analysis, organization structures, forecasting techniques and decision analysis. The *data analytics* tools help in the data mining processes from loading to transformation, aggregation, automated parameter, and process optimization.

II. COURSE OBJECTIVES:

The students will try to learn:

I. The role of business analytics within an organization.
II. The relationships between the underlying business processes of an organization.
III. To gain an understanding of how managers use business analytics to formulate

III COURSE OUTCOMES:

After successful completion of the course, students will be able to:

CO1	Analyze data using statistical and business analytics technology	Analyze
CO2	Solve business problems and to support managerial decision making	Apply
CO3	Choose business decision Strategies with the without outcome probabilities	Apply
CO4	Perform statistical analysis on variety of data	Apply
CO5	Experiment Data using Business Analytics Technology	Apply

UNIT-I	BUSINESS ANALYTICS	Classes: 09

Business analytics: Overview of Business analytics, Scope of Business analytics, Business Analytics Process, Relationship of Business Analytics Process and organization, competitive advantages of Business Analytics. Statistical Tools: Statistical Notation, Descriptive Statistical methods, Review of probability distribution and data modeling, sampling and estimation methods overview.

UNIT-II	REGRESSION ANALYSIS	Classes: 09

Trendiness and Regression Analysis: Modeling Relationships and Trends in Data, simple Linear Regression. Important Resources, Business Analytics Personnel, Data and models for Business analytics, problem solving, Visualizing and Exploring Data, Business Analytics Technology.

UNIT-III	ORGANIZATION STRUCTURES	Classes: 09

Organization Structures of Business analytics, Team management, Management Issues, Designing Information Policy, Outsourcing, Ensuring Data Quality, Measuring contribution of Business analytics, Managing Changes.

Descriptive Analytics, predictive analytics, predicative Modeling, Predictive analytics analysis, Data Mining, Data Mining Methodologies, Prescriptive analytics and its step in the business analytics Process, Prescriptive Modeling, nonlinear Optimization.

UNIT-IV	FORCASTING TECHNIQUES	Classes: 09
Forecasting Techniques: Qualitative and Judgmental Forecasting, Statistical Forecasting Models, Forecasting Models for Stationary Time Series, Forecasting Models for Time Series with a Linear Trend, Forecasting Time Series with Seasonality, Regression Forecasting with Casual Variables, Selecting Appropriate Forecasting Models. Monte Carlo Simulation and Risk Analysis: Monte Carle Simulation Using Analytic Solver Platform, New-Product Development Model, Newsvendor Model, Overbooking Model, Cash Budget Model.		
UNIT-V	**DECISION ANALYSIS**	**Classes: 09**
Decision Analysis: Formulating Decision Problems, Decision Strategies with the without Outcome Probabilities, Decision Trees, The Value of Information, Utility and Decision Making. Recent Trends in: Embedded and collaborative business intelligence, Visual data recovery, Data Storytelling and Data journalism.		
Text Books		
1. James Evans, "Business Analytics", Persons Education.		
Reference Books		
1. Marc J. Schniederjans, Dara G. Schniederjans, Christopher M. Starkey, "Business analytics Principles, Concepts, and Applications", Pearson FT Press.		
Web References		
1. http://nptel.ac.in/courses/110107092/		
E-Text Books		
1. http://nptel.ac.in/downloads/110107092/		

INDUSTRIAL SAFETY

Course Code	Category	Hours / Week			Credits	Maximum Marks		
		L	T	P	C	CIA	SEE	Total
BCSB26	Open Elective	3	-	-	3	30	70	100
Contact Classes: 45	Tutorial Classes: Nil	Practical Classes: Nil				Total Classes: 45		

I. COURSE OVERVIEW:

In this course, students develop a comprehensive understanding of industrial safety principles and practices. They are equipped with the skills to identify, assess, and manage workplace hazards, promoting a culture of safety in their future engineering careers.

II. COURSE OBJECTIVES:

The students will try to learn:

I. Ensuring duty holders apply inherent safety principles in managing risks.
II. Prioritizing interventions based on the inherent hazards of the site and/or pipeline, performance of duty holders in controlling risks and other defined operational intelligence.
III. Identifying the underlying, as well as the immediate, causes of any deficiencies in duty holders arrangements for managing risks.
IV. Taking action to ensure immediate and underlying causes of failures of risk management are addressed.

III. COURSE OUTCOMES:

After successful completion of the course, students should be able to:

CO 1	Describe the theories of accident causation and preventive measures of industrial accidents.	Understand
CO 2	Summarize the functions of maintenance department and application tools used for maintenance	Understand
CO 3	Recall the corrosion and its prevention methods	Remember
CO 4	Outline the fault tracing methods of various types of equipment	Understand
CO 5	Explain the Periodic and preventive maintenance of mechanical and electrical equipment	Understand

IV. SYLLABUS

UNIT-I	INDUSTRIAL SAFTEY	Classes: 09

Industrial safety: Accident, causes, types, results and control, mechanical and electrical hazards, types, causes and preventive steps/procedure, describe salient points of factories act 1948 for health and safety, wash rooms, drinking water layouts, light, cleanliness, fire, guarding, pressure vessels, etc, Safety color codes. Fire prevention and firefighting, equipment and methods.

UNIT-II	MAINTENANCE ENGINEERING	Classes: 09

Fundamentals of maintenance engineering: Definition and aim of maintenance engineering, Primary and secondary functions and responsibility of maintenance department, Types of maintenance, Types and applications of tools used for maintenance, Maintenance cost & its relation with replacement economy, Service life of equipment.

UNIT-III	CORROSION AND PREVENTION TECHNIQUES	Classes: 09

Wear and Corrosion and their prevention: Wear- types, causes, effects, wear reduction methods, lubricants-types and applications, Lubrication methods, general sketch, working and applications, i.e. Screw down grease cup, ii. Pressure grease gun, iii. Splash lubrication, iv. Gravity lubrication, v. Wick feed lubrication vi. Side feed lubrication, vii. Ring lubrication.

Definition, principle and factors affecting the corrosion. Types of corrosion, corrosion prevention methods.		
UNIT-IV	**FAULT TRACING**	**Classes: 09**
Fault tracing: Fault tracing-concept and importance, decision tree concept, need and applications, sequence of fault finding activities, show as decision tree, draw decision tree for problems in machine tools, hydraulic, pneumatic, automotive, thermal and electrical equipment's like, I. Any one machine tool, ii. Pump iii. Air compressor, iv. Internal combustion engine, v. Boiler, vi. Electrical motors, Types of faults in machine tools and their general causes.		
UNIT-V	**PERODIC AND PREVENTIVE MAINTENANCE**	**Classes: 09**
Periodic and preventive maintenance: Periodic inspection-concept and need, degreasing, cleaning and repairing schemes, overhauling of mechanical components, overhauling of electrical motor, common troubles and remedies of electric motor, repair complexities and its use, definition, need, steps and advantages of preventive maintenance. Steps/procedure for periodic and preventive maintenance of: I. Machine tools, ii. Pumps, iii. Air compressors, iv. Diesel generating (DG) sets, Program and schedule of preventive maintenance of mechanical and electrical equipment, advantages of preventive maintenance. Repair cycle concept and importance.		
Text Books		
1. Higgins & Morrow, "Maintenance Engineering Handbook", Da Information Services. H. P. Garg, "Maintenance Engineering", S. Chand and Company.		
Reference Books		
1. Audels, "Pump-hydraulic Compressors", Mcgraw Hill Publication. Winterkorn, Hans, "Foundation Engineering Handbook", Chapman & Hall London.		
Web References		
1. https://onlinecourses.nptel.ac.in/noc18_mg42/preview		
E-Text Books		
1. http://portal.unimap.edu.my/portal/page/portal30/Lecturer%20Notes/KEJURUTERAAN_KOMPUTER/Semester%201%20Sidang%20Akademik%2020142015/DPT333%20Industrial%20safety%20and%20health/Chapter%201%20-%20Introduction%20-Zaizu_0.pdf		

OPERATIONS RESEARCH

Course Code	Category	Hours / Week			Credits	Maximum Marks		
		L	T	P	C	CIA	SEE	Total
BCSB27	Open Elective	3	-	-	3	30	70	100
Contact Classes: 45	Tutorial Classes: Nil	Practical Classes: Nil				Total Classes: 45		

I. COURSE OVERVIEW:

The course allow students to possess a solid understanding of optimization techniques and their applications. They are equipped with the skills to formulate and solve optimization problems, analyze and interpret results, and make optimal decisions in various domains such as operations management, logistics, finance, and engineering.

II. COURES OBJECTIVES:

The students will try to learn:

I. Apply the dynamic programming to solve problems of discreet and continuous variables.
II. Understand the concept of nonlinear programming.
III. Describe the sensitivity analysis.

III. COURSE OUTCOMES:

After successful completion of the course, students should be able to:

CO1	Recall the basics of operation research	Understand
CO2	Explain the characteristics and scope of OR	Understand
CO3	Outline and formulate mathematical problems	Understand
CO4	Select optimal problems solving techniques for a given problem using LP	Apply
CO5	Solve transportation, travelling sales man and Assignment problems	Apply

IV. COURSE OUTCOMES:

UNIT-I	**INTRODUCTION**	**Classes: 09**
Optimization Techniques, Model Formulation, models, General L.R Formulation, Simplex Techniques, Sensitivity Analysis, Inventory Control Models		
UNIT-II	**FORMULATION TECHNIQUES**	**Classes: 09**
Formulation of a LPP - Graphical solution revised simplex method - duality theory - dual simplex method - sensitivity analysis - parametric programming.		
UNIT-III	**NON LINEAR METHODS**	**Classes: 09**
Nonlinear programming problem - Kuhn-Tucker conditions min cost flow problem. max flow problem - CPM/PERT.		
UNIT-IV	**SCHEDULING MODELS**	**Classes: 09**
Scheduling and sequencing - single server and multiple server models - deterministic inventory models - Probabilistic inventory control models - Geometric Programming.		
UNIT-V	**DYNAMIC PROGRAMMING AND GAME THEORY**	**Classes: 09**
Competitive Models, Single and Multi-channel Problems, Sequencing Models, Dynamic Programming, Flow in Networks, Elementary Graph Theory, Game Theory Simulation		

Text Books
1. H.A. Taha, “Operations Research - An Introduction”, PHI, 2008 2. H.M. Wagner, “Principles of Operations Research”, PHI, Delhi, 1982. 3. J.C. Pant, “Introduction to Optimisation: Operations Research”, Jain Brothers, Delhi, 2008
Reference Books
1. Hitler Libermann,“Operations Research” McGraw Hill Publications, 2009. 2. Pannerselvam, “Operations Research” Prentice Hall of India, 2010. 3. Harvey M Wagner, “Principles of Operations Research” Prentice Hall of India, 2010.
Web References
1. https://onlinecourses.nptel.ac.in/noc17_mg10/preview
E-Text Books
1. http://nptel.ac.in/courses/112106134/

COST MANAGEMENT OF ENGINEERING PROJECTS

Course Code	Category	Hours / Week			Credits	Maximum Marks		
		L	T	P	C	CIA	SEE	Total
BCSB28	Open Elective	3	-	-	3	30	70	100
Contact Classes: 48	Tutorial Classes: Nil	Practical Classes: Nil				Total Classes: 48		

I. COURSE OVERVIEW:

The course allow students to have a comprehensive understanding of cost management principles and practices in engineering projects. They are equipped with the skills to plan, estimate, control, and communicate project costs effectively, contributing to the successful delivery of projects within budgetary constraints

II. COUSRE OBJECTIVES:

The students will try to learn:

I. Establish systems to help streamline the transactions between corporate support departments and the operating units.
II. Devise transfer pricing systems to coordinate the buyer-supplier interactions between decentralized organizational operating units
III. Use pseudo profit centers to create profit maximizing behavior in what were formerly cost centers.

III. COURSE OUTCOMES:

After successful completion of the course, students should be able to:

CO 1	Summarize the concept of strategic cost management, strategic cost analysis – target costing, life cycle costing and Kaizen costing and the cost drive concept.	Understand
CO 2	Describe the decision-making; relevant cost, differential cost, incremental cost and opportunity cost, objectives of a costing system.	Understand
CO 3	Interpret the meaning and different types of project management and project execution, detailed engineering activities.	Understand
CO 4	Understand the project contracts, cost behavior and profit planning types and contents, Bar charts and Network diagram	Understand
CO 5	Analyze by using quantitative techniques for cost management like PERT/CPM.	Analyze

IV. SYLLABUS:

UNIT-I	**INTRODUCTION**	**Classes: 09**
Introduction and Overview of the Strategic Cost Management Process		
UNIT-II	**COST CONCEPTS**	**Classes: 09**
Cost concepts in decision-making; Relevant cost, Differential cost, Incremental cost and OpportUNITy cost. Objectives of a Costing System; Inventory valuation; Creation of a Database for operational control; Provision of data for Decision-Making.		
UNIT-III	**PROJECT MANAGEMENT**	**Classes: 09**
Project: meaning, Different types, why to manage, cost overruns centers, various stages of project execution: conception to commissioning. Project execution as conglomeration of technical and nontechnical activities. Detailed Engineering activities. Pre project execution main clearances and documents. Project team: Role of each member. Importance Project site: Data required with significance. Project contracts. Types and contents. Project execution Project cost control. Bar charts and Network diagram. Project commissioning: mechanical and process.		

UNIT-IV	COST BEHAVIOR AND PROFIT PLANNING	Classes: 09
Cost Behavior and Profit Planning Marginal Costing; Distinction between Marginal Costing and Absorption Costing; Break-even Analysis, Cost-Volume-Profit Analysis. Various decision-making problems. Standard Costing and Variance Analysis. Pricing strategies: Pareto Analysis. Target costing, Life Cycle Costing. Costing of service sector. Just-in-time approach, Material Requirement, Planning, Enterprise Resource Planning, Total Quality Management and Theory of constraints. Activity-Based Cost Management, Bench Marking; Balanced Score Card and Value-Chain Analysis. Budgetary Control; Flexible Budgets; Performance budgets; Zero-based budgets. Measurement of Divisional profitability pricing decisions including transfer pricing.		
UNIT-V	**QUANTITATIVE TECHNIQUES**	**Classes: 09**
Quantitative techniques for cost management, Linear Programming, PERT/CPM, Transportation Problems, Assignment problems, Simulation, Learning Curve Theory.		

Text Books

1. Robert S Kaplan Anthony A. Alkinson, Management & Cost Accounting.
2. N.D. Vohra, Quantitative Techniques in Management, Tata McGraw Hill Book Co. Ltd.

Reference Books

1. Cost Accounting A Managerial Emphasis, Prentice Hall of India, New Delhi.
2. Charles T. Horngren and George Foster, Advanced Management Accounting.
3. Ashish K. Bhattacharya, Principles & Practices of Cost Accounting A. H. Wheeler publisher.

Web References

1. https://onlinecourses.nptel.ac.in/noc16_ce02/preview

E-Text Books

1. http://nptel.ac.in/downloads/110101003/

COMPOSITE MATERIALS

Course Code	Category	Hours / Week			Credits	Maximum Marks		
		L	T	P	C	CIA	SEE	Total
BCSB29	Open Elective	3	-	-	3	30	70	100
Contact Classes: 45	Tutorial Classes: Nil	Practical Classes: Nil				Total Classes: 45		

I. COURSE OVERVIEW:

In this course, students will gain insight into the manufacturing processes for composites, from choosing appropriate reinforcement fibers to integrating them with suitable matrices. They will develop an understanding of the challenges and considerations involved in achieving desired strength properties. This knowledge will enable them to evaluate and optimize the manufacturing processes for different types of composites based on specific application requirements.

II. COUSE OBJECTIVES:

The students will try to learn:

I. The manufacturing processes of reinforcement fibers and matrices for composites.
II. The concept of tailored design philosophy.

III. COURSE OUTCOMES:

After successful completion of the course, students should be able to:

CO 1	Identify the basic mechanical behavior of composite materials and make sound prediction on the likely behavior of new combinations of materials.	Understand
CO 2	Explain the properties of and applications of fibers, particle reinforcements and make use of rule of mixtures	Understand
CO 3	Interpret Manufacturing of Metal Matrix Composites, Properties and applications.	Understand
CO 4	Understand Manufacturing of polymer Matrix Composites, Properties and applications	Understand
CO 5	Recall the concepts of failure criteria of strength	Remember

IV. SYLLABUS:

UNIT-I	INTRODUCTION	Classes: 09

Definition – Classification and characteristics of Composite materials. Advantages and application of composites. Functional requirements of reinforcement and matrix. Effect of reinforcement (size, shape, distribution, volume fraction) on overall composite performance.

UNIT-II	REINFORCEMENTS	Classes: 09

Preparation-layup, curing, properties and applications of glass fibers, carbon fibers, Kevlar fibers and Boron fibers. Properties and applications of whiskers, particle reinforcements. Mechanical Behavior of composites: Rule of mixtures, Inverse rule of mixtures. Isostrain and Isostress conditions.

UNIT-III	MANUFACTURING OF METAL MATRIX COMPOSITES	Classes: 09

Casting, Solid State diffusion technique, Cladding, Hot isostatic pressing. Properties and applications. Manufacturing of Ceramic Matrix Composites.

Liquid Metal Infiltration, Liquid phase sintering. Manufacturing of Carbon, Carbon composites: Knitting, Braiding, Weaving. Properties and applications.

UNIT-IV	MANUFACTURING OF POLYMER MATRIX COMPOSITES	Classes: 09
Preparation of Moulding compounds and prepregs, hand layup method, Autoclave method, Filament winding method, Compression moulding, Reaction injection moulding. Properties and applications.		
UNIT-V	**STRENGTH**	**Classes: 09**
Laminar Failure Criteria-strength ratio, maximum stress criteria, maximum strain criteria, interacting failure criteria, hygrothermal failure. Laminate first play failure-insight strength; Laminate strength-ply discount truncated maximum strain criterion; strength design using caplet plots; stress concentrations.		
Text Books:		
1. R.W.Cahn, "Material Science and Technology" VCH, West Germany. 2. WD Callister, Jr., Adapted by R. Balasubramaniam, "Materials Science and Engineering, An introduction", John Wiley & Sons, NY, Indian edition, 2007.		
Reference Books:		
1. ed-Lubin, "Hand Book of Composite Materials" 2. Deborah D.L. Chung, "Composite Materials Science and Applications" 3. Danial Gay, Suong V. Hoa, and Stephen W. Tasi, "Composite Materials Design and Applications"		
Web References:		
1. https://freevideolectures.com/course/3479/processing-of-non-metals/5		
E-Text Books:		
1. https://www.asminternational.org/documents/10192/1849770/05287G_Sample_Chapter.pdf		

WASTE TO ENERGY

Course Code	Category	Hours / Week			Credits	Maximum Marks		
		L	T	P	C	CIA	SEE	Total
BCSB30	Open Elective	3	-	-	3	30	70	100
Contact Classes: 45	Tutorial Classes: Nil	Practical Classes: Nil				Total Classes: 45		

I. COURSE OVERVIEW:

In this course, students will gain insights into the principles associated with effective energy management using biomass resources. They will understand the different conversion technologies and their applications in sustainable energy systems. By applying these principles in their daily lives, students will be able to make informed decisions regarding energy consumption, resource utilization, and environmental sustainability.

II. COURSE OBJECTIVES:

The students will try to learn:

I. The principles associated with effective energy management and to apply these principles in the day to day life.
II. The collection, transfer and transport of municipal solid waste.
III. The design and operation of a municipal solid wasteland fill.
IV. The key processes involved in recovering energy from wastes, systematically evaluate the main operational challenges in operating thermal and biochemical energy from waste facilities.

III. COURSE OUTCOMES:

After successful completion of the course, students should be able to:

CO 1	**Identify** the different sources and types of solid waste by the properties of municipal solid waste for segregation and collection of waste.	Remember
CO 2	**Explain** the energy generation technologies from waste treatment plants and disposal of solid waste by aerobic composting and incineration process.	Understand
CO 3	**Illustrate** the classification, preliminary design considerations of landfill and methods of landfill disposal of solid to control greenhouse gases.	Analyze
CO 4	**Understand** the Composition, characteristics of leachate to control the emission of gases by monitoring the movement of landfill leachate.	Understand
CO 5	**Outline** the Biochemical conversion of biomass for energy generation by anaerobic digestion of solid waste.	Create

IV. SYLLABUS:

UNIT-I	**INTRODUCTION TO ENERGY FROM WASTE**	**Classes: 09**

Introduction to Energy from Waste: Classification of waste as fuel, Agro based, Forest residue, Industrial waste. MSW, Conversion devices. Incinerators, gasifiers, digestors

UNIT-II	**BIOMASS PYROLYSIS**	**Classes: 09**

Biomass Pyrolysis: Pyrolysis, Types, slow fast, Manufacture of charcoal, Methods, Yields and application, Manufacture of pyrolytic oils and gases, yields and applications.

UNIT-III	**BIOMASS GASIFICATION**	**Classes: 09**

Gasifiers, Fixed bed system, Downdraft and updraft gasifiers, Fluidized bed gasifiers, Design, construction and operation. Gasifier burner arrangement for thermal heating.

Gasifier engine arrangement and electrical power, Equilibrium and kinetic consideration in gasifier operation.

UNIT-IV	BIOMASS COMBUSTION	Classes: 09
Biomass stoves, Improved chullahs, types, some exotic designs, Fixed bed combustors, Types, inclined grate combustors, Fluidized bed combustors, Design, construction and operation - Operation of all the above biomass combustors.		
UNIT-V	**BIOGAS**	**Classes: 09**
Properties of biogas (Calorific value and composition), Biogas plant technology and status, Bio energy system. Design and constructional features, Biomass resources and their classification, Biomass conversion processes, Thermo chemical conversion, Direct combustion, biomass gasification, pyrolysis and liquefaction, biochemical conversion, anaerobic digestion. Types of biogas Plants, Applications. Alcohol production from biomass, Bio diesel production. Urban waste to energy conversion, Biomass energy programme in India.		
Text Books:		
1. Desai, Ashok V, "Non Conventional Energy", Wiley Eastern Ltd., 1990.		
Reference Books:		
1. Khandelwal, K. C. and Mahdi, S. S, "Biogas Technology - A Practical Hand Book", Vol. I & II Tata McGraw Hill Publishing Co. Ltd., 1983. 2. Challal, D. S, "Food, Feed and Fuel from Biomass", IBH Publishing Co. Pvt. Ltd., 1991.		
Web References:		
1. http://nptel.ac.in/courses/103107125/		
E-Text Books:		
1. Biomass Conversion and Technology, C. Y. WereKo-Brobby and E. B. Hagan, John Wiley & Sons, 1996..		

ENGLISH FOR RESEARCH PAPER WRITING

Course Code	Category	Hours / Week			Credits	Maximum Marks		
		L	T	P	C	CIA	SEE	Total
BCSB32	Audit	2	-	-	0	30	70	100
Contact Classes: 24	Tutorial Classes: Nil	Practical Classes: Nil				Total Classes: 24		

I. COURSE OVERVIEW:

In this course, students will be equipped with the necessary tools to effectively communicate their research findings in a scholarly manner. They will develop the ability to write clear, concise, and well-structured research papers that adhere to academic standards. These skills will not only benefit them in their academic pursuits but also in their future professional careers as researchers, scholars, and professionals in various fields

II. COURSE OBJECTIVES:

The course should enable the students to:

I. Understand that how to improve your writing skills and level of readability
II. Learn about what to write in each section
III. Understand the skills needed when writing a Title Ensure the good quality of paper at very first-time submission.

III. COURSE OUTCOMES:

After successful completion of the course, students should be able to:

CO 1	Interpret the technique of determining a research problem for a crucial part of the research study	Apply
CO 2	Examine the way of methods for avoiding plagiarism in research	Understand
CO 3	Apply the feasibility and practicality of research methodology for a proposed project.	Apply
CO 4	Make use of the legal procedure and document for claiming patent of invention.	Apply
CO 5	Identify different types of intellectual properties, the right of ownership, scope of protection to create and extract value from IP	Apply

IV. SYLLABUS:

UNIT-I	**PLANNING AND PREPARATION**	**Classes: 04**
Planning and Preparation, Word Order, Breaking up long sentences, Structuring Paragraphs and Sentences, Being Concise and Removing Redundancy, Avoiding Ambiguity and Vagueness		
UNIT-II	**ABSTRACT**	**Classes: 05**
Clarifying Who Did What, Highlighting Your Findings, Hedging and Criticizing, Paraphrasing and Plagiarism, Sections of a Paper, Abstracts. Introduction		
UNIT-III	**DISCUSSION AND CONCLUSIONS**	**Classes: 05**
Review of the Literature, Methods, Results, Discussion, Conclusions, The Final Check. key skills are needed when writing a Title, key skills are needed when writing an Abstract, key skills are needed when writing an Introduction, skills needed when writing a Review of the Literature.		
UNIT-IV	**WRITING SKILLS**	**Classes: 05**
Skills are needed when writing the Methods, skills needed when writing the Results, skills are needed when writing the Discussion, skills are needed when writing the Conclusions		

UNIT-V	QUALITY AND TIME MAINTENANCE	Classes: 05
Useful phrases, how to ensure paper is as good as it could possibly be the first- time submission		
Text Books:		
1. Goldbort R, "Writing for Science", Yale University Press. 2011. 2. Adrian Wallwork, "English for Writing Research Papers", Springer New York Dordrecht Heidelberg London, 2011.		
Reference Books:		
1. Highman N, "Handbook of Writing for the Mathematical Sciences", SIAM Highman's book.		
Web References:		
1. http://saba.kntu.ac.ir/eecd/ecourses/Seminar90/2011%20English%20for%20Writing%20Research%20Papers.pdf		
E-Text Books:		
1. Day R (2006) How to Write and Publish a Scientific Paper, Cambridge University Press.		

DISASTER MANAGEMENT

Course Code	Category	Hours / Week			Credits	Maximum Marks		
		L	T	P	C	CIA	SEE	Total
BCSB33	Audit	2	-	-	0	30	70	100
Contact Classes: 24	Tutorial Classes: Nil	Practical Classes: Nil				Total Classes: 24		

I. COURSE OVERVIEW:

In the course on disaster management, students will explore a range of important topics and gain valuable knowledge and skills to effectively address and mitigate the impact of disasters and covers areas like Repercussions of Disasters and Hazards, Disaster-Prone Areas in India, Risk Assessment and Disaster Mitigation

II. COURSE OBJECTIVES:

The course should enable the students to:

I. Learn to demonstrate a critical understanding of key concepts in disaster risk reduction and humanitarian response.
II. Critically evaluate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.
III. Develop an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.
IV. Critically understand the strengths and weaknesses of disaster management approaches, planning and programming in different countries, particularly their home country or the countries they work in.

III. COURSE OUTCOMES:

After successful completion of the course, students should be able to:

CO 1	Understand to describe the basic types of Environmental hazards and disasters. Understand how to react effectively to natural, manmade, and technological threats.	Understand
CO 2	Understand how to react effectively to natural, manmade, and planetary hazards	Understand
CO 3	Explore the history of the field and comprehend how past events are earthquake, landslides, and volcanic hazards.	Analyze
CO 4	Describe the basic concepts of the emergency management cycle mitigation, preparedness, response, and recovery	Understand
CO 5	Recognizes the stakeholders in disaster management system, their jurisdiction and responsibilities	Remember

IV. SYLLABUS:

UNIT-I	INTRODUCTION	Classes: 04

Disaster: Definition, Factors And Significance; Difference Between Hazard And Disaster; Natural And Manmade Disasters: Difference, Nature, Types And Magnitude.

UNIT-II	REPERCUSSIONS OF DISASTERS AND HAZARDS	Classes: 05

Economic Damage, Loss Of Human And Animal Life, Destruction Of Ecosystem. Natural Disasters: Earthquakes, Volcanisms, Cyclones, Tsunamis, Floods, Droughts And Famines, Landslides And Avalanches, Man-made disaster: Nuclear Reactor Meltdown, Industrial Accidents, Oil Slicks And Spills, Outbreaks Of Disease And Epidemics, War And Conflicts.

UNIT-III	DISASTER PRONE AREAS IN INDIA	Classes: 05
Study Of Seismic Zones; Areas Prone To Floods And Droughts, Landslides And Avalanches; Areas Prone To Cyclonic And Coastal Hazards With Special Reference To Tsunami; Post-Disaster Diseases And Epidemics		
UNIT-IV	**DISASTER PREPAREDNESS AND MANAGEMENT**	**Classes: 05**
Preparedness: Monitoring of Phenomena Triggering A Disaster Or Hazard; Evaluation Of Risk: Application Of Remote Sensing, Data From Meteorological And Other Agencies, Media Reports: Governmental And Community Preparedness.		
UNIT-V	**RISK ASSESSMENT & DISASTER MITIGATION**	**Classes: 05**
Disaster Risk: Concept And Elements, Disaster Risk Reduction, Global And National Disaster Risk Situation. Techniques Of Risk Assessment, Global Co-Operation In Risk Assessment And Warning, People's Participation In Risk Assessment. Strategies for Survival. Disaster Mitigation: Meaning, Concept And Strategies Of Disaster Mitigation, Emerging Trends In Mitigation. Structural Mitigation And Non-Structural Mitigation, Programs Of Disaster Mitigation In India.		
Text Books:		
1. R. Nishith, Singh AK, "Disaster Management in India: Perspectives, issues and strategies", New Royal book Company.		
Reference Books:		
1. Sahni, PardeepEt.Al, "Disaster Mitigation Experiences and Reflections", Prentice Hall Of India, New Delhi. Goel S. L. "Disaster Administration and Management Text and Case Studies", Deep & Deep Publication Pvt. Ltd., New Delhi.		
Web References:		
1. http://nptel.ac.in/courses/105101010/downloads/Lecture37.pdf		
E-Text Books:		
1. Disaster management by Vinod k. Sharma		

SANSKRIT FOR TECHNICAL KNOWLEDGE

Course Code	Category	Hours / Week			Credits	Maximum Marks		
		L	T	P	C	CIA	SEE	Total
BCSB34	Audit	2	-	-	0	30	70	100
Contact Classes: 24	Tutorial Classes: Nil	Practical Classes: Nil				Total Classes: 24		

I. COURSE OVERVIEW:

In this course, Studying Sanskrit enhances students' analytical thinking and problem-solving abilities. The intricate grammar and logical structure of Sanskrit nurture their analytical skills, enabling them to dissect complex concepts and extract profound insights. This heightened analytical thinking can be applied across different technical disciplines, fostering innovative solutions to contemporary challenges

II. COURSE OBJECTIVES:

The course should enable the students to:

I. Get a working knowledge in illustrious Sanskrit, the scientific language in the world
II. Learning of Sanskrit to improve brain functioning
III. Learning of Sanskrit to develop the logic in mathematics, science & other subjects enhancing the memory power
IV. The engineering scholars equipped with Sanskrit will be able to explore the huge knowledge from ancient literature.

III. COURSE OUTCOMES:

After successful completion of the course, students should be able to:

CO 1	Understand the basic Sanskrit grammar	Understand
CO 2	Formulate simple sentences	Apply
CO 3	Apply order and roots	Apply
CO 4	Understand Ancient Sanskrit literature about science & technology	Understand
CO 5	Develop logical thinking being a logical language in technical concepts	Apply

IV. SYLLUBUS:

UNIT-I	**INTRODUCTION**	**Classes: 04**
Alphabets in Sanskrit, Past/Present/Future Tense		
UNIT-II	**SENTENCES**	**Classes: 04**
Simple Sentences		
UNIT-III	**ROOTS**	**Classes: 04**
Order, Introduction of roots		
UNIT-IV	**SANSKRIT LITERATURE**	**Classes: 04**
Technical information about Sanskrit Literature		
UNIT-V	**TECHNICAL CONCEPTS**	**Classes: 08**
Technical concepts of Engineering-Electrical, Mechanical, Architecture, Mathematics		

Text Books:

1. Suresh Soni, “India’s Glorious Scientific Tradition”, Ocean books (P) Ltd., New Delhi..

Reference Books:
1. Dr.Vishwas, “Abhyaspustakam”, Samskrita-Bharti Publication, New Delhi
Web References:
1. http://learnsanskritonline.com/
E-Text Books:
1. Prathama Deeksha-Vempati Kutumb Shastri, “Teach Yourself Sanskrit”, Rashtriya Sanskri Sansthanam, New Delhi Publication.

VALUE EDUCATION

Course Code	Category	Hours / Week			Credits	Maximum Marks		
		L	T	P	C	CIA	SEE	Total
BCSB35	Audit	2	-	-	0	30	70	100
Contact Classes: 24	Tutorial Classes: Nil	Practical Classes: Nil				Total Classes: 24		

I. COURSE OVERVIEW:

In the course on value education, students emerge with a heightened sense of self-awareness, a strong moral foundation, and the skills necessary for personal and professional success. They are equipped with the knowledge and tools to navigate ethical challenges, contribute positively to society, and lead a purposeful and fulfilling life based on their core values and principles.

II. COURSE OBJECTIVES:

The course should enable the students to:

I. Understand value of education and self- development
II. Imbibe good values in students
III. Let the should know about the importance of character

III. COURSE OUTCOMES:

After successful completion of the course, students should be able to:

CO 1	Understand the significance of ethical human conduct and self-development	Understand
CO 2	Adopt value-based living and holistic technologies to save nature	Apply
CO 3	Inculcate positive thinking, dignity of labor and religious tolerance	Apply
CO 4	Develop the overall Character and Competence through self-management	Analyze
CO 5	Practice Self-control. Honesty through Studying effectively all religious messages	Apply

IV. SYLLABUS:

UNIT-I	VALUES AND SELF-DEVELOPMENT	Classes: 04

Values and self-development. Social values and individual attitudes. Work ethics, Indian vision of humanism. Moral and non- moral valuation. Standards and principles. Value judgments.

UNIT-II	CULTIVATION OF VALUES	Classes: 06

Importance of cultivation of values. Sense of duty. Devotion, Self-reliance. Confidence, Concentration. Truthfulness, Cleanliness. Honesty, Humanity. Power of faith, National Unity. Patriotism. Love for nature, Discipline.

UNIT-III	PERSONALITY AND BEHAVIOR DEVELOPMENT	Classes: 06

Personality and Behavior Development - Soul and Scientific attitude. Positive Thinking. Integrity and discipline. Punctuality, Love and Kindness. Avoid fault Thinking. Free from anger, Dignity of labor. Universal brotherhood and religious tolerance. True friendship. Happiness Vs suffering, love for truth. Aware of self-destructive habits. Association and Cooperation. Doing best for saving nature.

UNIT-IV	CHARACTER AND COMPETENCE	Classes: 03

Character and Competence –Holy books vs Blind faith. Self-management and Good health. Science of reincarnation. Equality, Nonviolence, Humility, Role of Women.

UNIT-V	SELF CONTROL	Classes: 03
All religions and same message. Mind your Mind, Self-control. Honesty, Studying effectively.		
Text Books:		
1. Chakroborty, S.K. “Values and Ethics for organizations Theory and practice”, Oxford University Press, New Delhi.		
Web References:		
1. http://www.best-personal-development-books.com/personal-value-development.html 2. http://nptel.ac.in/courses/109104068/		
E-Text Books:		
1. R.P. Shukla, “Value education and human rights”.		

CONSTITUTION OF INDIA

Course Code	Category	Hours / Week			Credits	Maximum Marks		
		L	T	P	C	CIA	SEE	Total
BCSB36	Audit	2	-	-	0	30	70	100
Contact Classes: 24	Tutorial Classes: Nil	Practical Classes: Nil				Total Classes: 24		

I. COURSE OVERVIEW:

The course on the Constitution of India provides students with a comprehensive understanding of the historical context, principles, and structure of the Indian Constitution. It explores the journey and philosophy behind the making of the Indian Constitution, highlighting the vision and ideals of the founding fathers.

II. COURSE OBJECTIVES:

The course should enable the students to:

I. Understand the premises informing the twin themes of liberty and freedom from a civil right perspective.
II. Address the growth of Indian opinion regarding modern Indian intellectuals' constitutional role and entitlement to civil and economic rights as well as the emergence of nationhood in the early years of Indian nationalism.
III. Address the role of socialism in India after the commencement of the Bolshevik Revolution in 1917 and its impact on the initial drafting of the Indian Constitution.

III. COURSE OUTCOMES:

After successful completion of the course, students should be able to:

CO 1	Describe historical background of the constitution making and its importance for building a democratic India.	Understand
CO 2	Understand the Constitutional Rights and and duties	Understand
CO 3	Explain the functioning of three wings of the government i.e., executive, legislative and judiciary	Understand
CO 4	Analyse the decentralization of power between central, state and local self-government.	Analyze
CO 5	Apply the knowledge in strengthening of the constitutional institutions like CAG, Election Commission and UPSC for sustaining democracy	Apply

IV. SYLLABUS:

UNIT-I	HISTORY OF MAKING OF THE INDIAN CONSTITUTION & PHILOSOPHY OF THE INDIAN CONSTITUTION	Classes: 08

History of Making of the Indian Constitution: History, Drafting Committee, (Composition & Working)
Philosophy of the Indian Constitution: Preamble, Salient Features

UNIT-II	CONTOURS OF CONSTITUTIONAL RIGHTS & DUTIES	Classes: 04

Fundamental Rights, Right to Equality, Right to Freedom, Right against Exploitation, Right to Freedom of Religion, Cultural and Educational Rights, Right to Constitutional Remedies, Directive Principles of State Policy, Fundamental Duties.

UNIT-III	ORGANS OF GOVERNANCE	Classes: 04

Parliament, Composition, Qualifications and Disqualifications, Powers and Functions, Executive President, Governor, Council of Minister.

Judiciary, Appointment and Transfer of Judges, Qualifications, Powers and Functions.

UNIT-IV	LOCAL ADMINISTRATION	Classes: 04
District's Administration head: Role and Importance, Municipalities: Introduction, Mayor and role of Elected Representative, CEO of Municipal Corporation. Pachayati raj: Introduction, PRI: Zila Pachayat. Elected officials and their roles, CEO Zila Pachayat: Position and role. Block level: Organizational Hierarchy (Different departments),Village level: Role of Elected and Appointed officials, Importance of grass root democracy		
UNIT-V	ELECTION COMMISSION	Classes: 04
Election Commission: Role and Functioning. Chief Election Commissioner and Election Commissioners. State Election Commission: Role and Functioning. Institute and Bodies for the welfare of SC/ST/OBC and women.		

Text Books:

1. Dr. S. N. Busi, "Dr. B. R. Ambedkar framing of Indian Constitution", 1st Edition, 2015.
2. M. P. Jain, "Indian Constitution Law", Lexis Nexis, 7th Edition,2014.

Reference Books:

1. The Constitution of India, 1950 (Bare Act), Government Publication.
2. D.D. Basu, "Introduction to the Constitution of India", Lexis Nexis, 2015.

Web References:

1. http://www.constitution.org/cons/india/p18.html

E-Text Books:

1. https://www.india.gov.in/my-government/constitution-india/constitution-india-full-text

PEDAGOGY STUDIES

Course Code	Category	Hours / Week			Credits	Maximum Marks		
		L	T	P	C	CIA	SEE	Total
BCSB37	Audit	2	-	-	0	30	70	100
Contact Classes: 24	Tutorial Classes: Nil	Practical Classes: Nil				Total Classes: 24		

I. COURSE OVERVIEW:

In this course in pedagogy studies, students gain a solid foundation in educational principles and practices. They develop a deep understanding of effective teaching and learning strategies, empowering them to create engaging and meaningful learning experiences for their future students. Whether pursuing a career in teaching or any other field that involves knowledge transfer, students emerge with the knowledge and skills to inspire and facilitate learning, making a positive impact on the lives of others.

II.COURSE OBJECTIVES:

The course should enable the students to:

I. Review existing evidence on the review topic to inform program design and policy making undertaken by the DFID, other agencies and researchers.
II. Identify critical evidence gaps to guide the development.

III. COURSE OUTCOMES:

After successful completion of the course, students should be able to:

CO 1	Identify the Methodology and conceptual framework of teachers education	Understand
CO 2	Understand pedagogical practices are being used by teachers in formal and informal classrooms in developing countries	Understand
CO 3	Interpret the evidence on the effectiveness of these pedagogical practices, in what conditions, and with what population of learners	Understand
CO 4	Classify the importance of class room practice, curriculum and learning in Professional Development.	Understand
CO 5	Summarize teacher education (curriculum and practicum) and the school curriculum and guidance materials best support effective pedagogy	Understand

IV. SYLLABUS:

UNIT-I	INTRODUCTION	Classes: 04

Introduction And Methodology: Aims and rationale, Policy background, Conceptual framework and terminology. Theories of learning, Curriculum, Teacher education. Conceptual framework, Research questions**.** Overview of methodology and Searching.

UNIT-II	THEMATIC OVERVIEW	Classes: 02

Thematic overview: Pedagogical practices are being used by teachers in formal and informal classrooms in developing countries. Curriculum, Teacher education.

UNIT-III	PEDAGOGICAL PRACTICES	Classes: 04

Evidence on the effectiveness of pedagogical practices. Methodology for the in depth stage: quality assessment of included studies. How can teacher education (curriculum and practicum) and the school curriculum and guidance materials best support effective pedagogy? Theory of change.

Strength and nature of the body of evidence for effective pedagogical practices. Pedagogic theory and pedagogical approaches. Teachers' attitudes and beliefs and Pedagogic strategies.

UNIT-IV	PROFESSIONAL DEVELOPMENT	Classes: 04
Professional Development: alignment with classroom practices and follows up Support. Peer support. Support from the head teacher and the community. Curriculum and assessment Barriers to learning: limited resources and large class sizes.		
UNIT-V	**RESEARCH GAPS**	**Classes: 02**
Research gaps and future directions, Research design**,** Contexts**,** Pedagogy**.** Teacher education**.** Curriculum and assessment**.** Dissemination and research impact.		

Text Books:

1. Ackers J, Hardman F, "Classroom interaction in Kenyan primary schools", Compare, 31 (2), 245-261.
2. Agrawal M, "Curricular reform in schools: The importance of evaluation", Journal of Curriculum Studies, 36 (3): 361-379.

Reference Books:

1. AkyeampongK, "Teacher training in Ghana - does it count?" Multi-site teacher education research project (MUSTER) country report 1. London: DFID.
2. Akyeampong K, Lussier K, Pryor J, Westbrook J, "Improving Teaching and Learning of Basic Maths and Rreading in Africa: Does teacher preparation count?" International Journal Educational Development, 33 (3): 272–282.

Web References:

1. www.pratham.org/images/resource%20working%20paper%202.pdf.

Alexander RJ (2001) Culture and pedagogy: International comparisons in primary education Oxford and Boston: Blackwell

E-Text Books:

1. www.pratham.org/images/resource%20working%20paper%202.pdf.

STRESS MANAGEMENT BY YOGA

Course Code	Category	Hours / Week			Credits	Maximum Marks		
		L	T	P	C	CIA	SEE	Total
BCSB38	Audit	2	-	-	0	30	70	100
Contact Classes: 24	Tutorial Classes: Nil	Practical Classes: Nil				Total Classes: 24		

I. COURSE OVERVIEW:

In a course on stress management by yoga, engineering students learn a variety of yoga techniques and principles that promote physical, mental, and emotional well-being. These techniques include yoga postures (asanas), breathing exercises (pranayama), meditation, and relaxation techniques.

II. COURSE OBJECTIVES:

The students will try to learn:

I. How to achieve overall health of body and mind.
II. How to overcome stress.

III. COURSE OUTCOMES:

After successful completion of the course, students should be able to: (Same as R18)

CO 1	Understand Ashtanga yog and its impartance	Understand
CO 2	Identify the Dos and Do nots of Life by practicing the Yam and Niyam	Analyze
CO 3	Interpret the Shaucha and its components	Understand
CO 4	Make use of breathing techniques and Asan and Pranayam	Understand
CO 5	Develop healthy mind in a healthy body thus improving social health also	Apply

IV. SYLLABUS:

UNIT-I	**INTRODUCTION**	**Classes: 08**
Definitions of Eight parts of yog. (Ashtanga)		
UNIT-II	**YAM AND NIYAM**	**Classes: 04**
Yam and Niyam. Do`s and Don't's in life. Ahinsa, satya, astheya, bramhacharya and aparigraha		
UNIT-III	**SHAUCHA**	**Classes: 04**
Shaucha, santosh, tapa, swadhyay, ishwarpranidhan		
UNIT-IV	**ASAN AND PRANAYAM**	**Classes: 04**
Asan and Pranayam. Various yog poses and their benefits for mind & body		
UNIT-V	**BREATHING TECHNIQUES**	**Classes: 04**
Regularization of breathing techniques and its effects-Types of pranayam		

Text Books:

1. Swami Vivekananda, "Rajayoga or conquering the Internal Nature", Advaita Ashrama (Publication Department), Kolkata

Reference Books:

1. Janardan Swami, "Yogic Asanas for Group Tarining-Part-I", Yogabhyasi Mandal, Nagpur

Web References:

1. https://americanyoga.school/course/anatomy-for-asana/ 2. https://www.yogaasanasonline.com/
E-Text Books:
1. “Stress Management By Yoga” by Todd A. Hoover, M. D. D., Ht.

PERSONALITY DEVELOPMENT THROUGH LIFE ENLIGHTENMENT SKILLS

Course Code	Category	Hours / Week			Credits	Maximum Marks		
		L	T	P	C	CIA	SEE	Total
BCSB39	Audit	2	-	-	0	30	70	100
Contact Classes: 24	Tutorial Classes: Nil	Practical Classes: Nil				Total Classes: 24		

I. COURSE OVERVIEW:

In this course, students delve into various aspects of personal development and self-awareness. They learn techniques to improve self-confidence, self-esteem, and self-awareness, which are vital for thriving in their engineering careers. Students explore their strengths, weaknesses, values, and beliefs, enabling them to develop a clearer understanding of themselves and their goals.

II. COURSE OBJECTIVES:

The students will try to learn:

I. How to achieve the highest goal happily
II. How a person become with stable mind, pleasing personality and determination
III. Awaken wisdom in students

III. COURSE OUTCOMES:

After successful completion of the course, students should be able to:

CO 1	**Summarize** steps to develop personality with stable mind, pleasing manners and determination.	Understand
CO 2	**Identify** day to day work and duties for developing peace and prosperity as depicted in Geeta.	Analyze
CO 3	**Formulate** the daily life style by depicting the verses from Bhagavatgeetha.	Analyze
CO 4	**Outline** the verses of Shrimad Bhagavad Geetha for holistic development.	Create
CO 5	Demonstrates personality development by verses of Bhagavatgeetha.	Create

IV. SYLLUBUS:

UNIT-I	**HOLISTIC DEVELOPMENT**	**Classes: 08**
Neetisatakam-Holistic development of personality, Verses- 19,20,21,22 (wisdom), Verses- 29,31,32 (pride & heroism), Verses- 26,28,63,65 (virtue),Verses- 52,53,59 (dont's),Verses- 71,73,75,78 (do's)		
UNIT-II	**BHAGWAD GEETA**	**Classes: 04**
Approach to day to day work and duties. Shrimad BhagwadGeeta: Chapter 2-Verses 41, 47,48. Chapter 3-Verses 13, 21, 27, 35.		
UNIT-III	**BHAGWAD GEETA**	**Classes: 04**
Shrimad BhagwadGeeta: Chapter 6-Verses 5, 13, 17, 23, 35, Chapter 18-Verses 45, 46, 48.		
UNIT-IV	**BASIC KNOWLEDGE**	**Classes: 04**
Statements of basic knowledge. Shrimad BhagwadGeeta: Chapter2-Verses 56, 62, 68. Chapter 12 -Verses 13, 14, 15, 16,17, 18		

UNIT-V	ROLE MODEL	Classes: 04
Personality of Role model. Shrimad BhagwadGeeta: Chapter2-Verses 17, Chapter 3-Verses 36,37,42, Chapter 4-Verses 18, 38,39. Chapter18 – Verses 37,38,63		
Text Books:		
1. P.Gopinath, “Bhartrihari’s Three Satakam (Niti-sringar-vairagya)”, Rashtriya Sanskrit Sansthanam, New Delhi.		
Reference Books:		
1. Swami Swarupananda, “Srimad Bhagavad Gita”,Advaita Ashram (Publication Department), Kolkata.		
Web References:		
1. http://openlearningworld.com/section_personality_development.html		
E-Text Books:		
1. http://persmin.gov.in/otraining/UNDPProject/undp_UNITs/Personality%20Dev%20N%20DLM.pdf		

FREQUENTLY ASKED QUESTIONS AND ANSWERS ABOUT AUTONOMY

1. **Who grants Autonomy? UGC, Govt., AICTE or University**

   In case of Colleges affiliated to a university and where statutes for grant of autonomy are ready, it is the respective University that finally grants autonomy but only after concurrence from the respective state Government as well as UGC. The State Government has its own powers to grant autonomy directly to Govt. and Govt. aided Colleges.

2. **Shall IARE award its own Degrees?**

   No. Degree will be awarded by Jawaharlal Nehru Technological University, Hyderabad with a mention of the name IARE on the Degree Certificate.

3. **What is the difference between a Deemed University and an Autonomy College?**

   A Deemed University is fully autonomous to the extent of awarding its own Degree. A Deemed University is usually a Non-Affiliating version of a University and has similar responsibilities like any University. An Autonomous College enjoys Academic Autonomy alone. The University to which an autonomous college is affiliated will have checks on the performance of the autonomous college.

4. **How will the Foreign Universities or other stake – holders know that we are an Autonomous College?**

   Autonomous status, once declared, shall be accepted by all the stake holders. The Govt. of Telangana mentions autonomous status during the First Year admission procedure. Foreign Universities and Indian Industries will know our status through our website.

5. **What is the change of Status for Students and Teachers if we become Autonomous?**

   An autonomous college carries a prestigious image. Autonomy is actually earned out of our continued past efforts on academic performances, our capability of self- governance and the kind of quality education we offer.

6. **Who will check whether the academic standard is maintained / improved after Autonomy? How will it be checked?**

   There is a built in mechanism in the autonomous working for this purpose. An Internal Committee called Academic Programme Evaluation Committee, which will keep a watch on the academics and keep its reports and recommendations every year. In addition the highest academic council also supervises the academic matters. The standards of our question papers, the regularity of academic calendar, attendance of students, speed and transparency of result declaration and such other parameters are involved in this process.

7. **Will the students of IARE as an Autonomous College qualify for University Medals and Prizes for academic excellence?**

   No. IARE has instituted its own awards, medals, etc. for the academic performance of the students. However for all other events like sports, cultural on co-curricular organized by the University the students shall qualify.

8. **Can IARE have its own Convocation?**

   No. Since the University awards the Degree the Convocation will be that of the University, but there will be Graduation Day at IARE.

9. **Can IARE give a provisional degree certificate?**

   Since the examinations are conducted by IARE and the results are also declared by IARE, the college sends a list of successful candidates with their final Grades and Grade Point Averages including CGPA to the University. Therefore with the prior permission of the University the college will be entitled to give the provisional certificate.

10. **Will Academic Autonomy make a positive impact on the Placements or Employability?**
Certainly. The number of students qualifying for placement interviews is expected to improve, due to rigorous and repetitive classroom teaching and continuous assessment. Also the autonomous status is more responsive to the needs of the industry. As a result therefore, there will be a lot of scope for industry oriented skill development built-in into the system. The graduates from an autonomous college will therefore represent better employability.

11. **What is the proportion of Internal and External Assessment as an Autonomous College?**
Presently, it is 70 % external and 30% internal. As the autonomy matures the internal assessment component shall be increased at the cost of external assessment.

12. **Is it possible to have complete Internal Assessment for Theory or Practicals?**
Yes indeed. We define our own system. We have the freedom to keep the proportion of external and internal assessment component to choose.

13. **Why Credit based Grade System?**
The credit based grade system is an accepted standard of academic performance the world over in all Universities. The acceptability of our graduates in the world market shall improve.

14. **What exactly is a Credit based Grade System?**
The credit based grade system defines a much better statistical way of judging the academic performance. One Lecture Hour per week of Teaching Learning process is assigned One Credit. One hour of laboratory work is assigned half credit. Letter Grades like A, B,C,D, etc. are assigned for a Range of Marks. (e.g. 91% and above is A+, 80 to 90 % could be A etc.) in Absolute Grading System while grades are awarded by statistical analysis in relative grading system. We thus dispense with sharp numerical boundaries. Secondly, the grades are associated with defined Grade Points in the scale of 1 to 10. Weighted Average of Grade Points is also defined Grade Points are weighted by Credits and averaged over total credits in a Semester. This process is repeated for all Semesters and a CGPA defines the Final Academic Performance

15. **What are the norms for the number of Credits per Semester and total number of Credits for UG/PG programme?**
These norms are usually defined by UGC or AICTE. Usually around 25 Credits per semester is the accepted norm.

16. **What is a Semester Grade Point Average (SGPA)?**
The performance of a student in a semester is indicated by a number called SGPA. The SGPA is the weighted average of the grade points obtained in all the courses registered by the student during the semester.

$$SGPA = \sum_{i=1}^{n} (C_i G_i) / \sum_{i=1}^{n} C_i$$

Where, C_i is the number of credits of the i^{th} course and $G_i$is the grade point scored by the student in the i^{th} course and $i$represent the number of courses in which a student registered in the concerned semester. SGPA is rounded to two decimal places.

17. **What is a Cumulative Grade Point Average (CGPA)?**
An up-to-date assessment of overall performance of a student from the time of his first registration is obtained by calculating a number called CGPA, which is weighted average of the grade points obtained in all the courses registered by the students since he entered the Institute.

$$CGPA = \sum_{j=1}^{n} (C_i S_i) / \sum_{j=1}^{n} C_i$$

Where,S_i is the SGPA of the i^{th}semester and $C_i$is the total number of credits in that semester and *j*represent the number of courses in which a student's is registered upto the semester. CGPA is rounded to two decimal places.

18. Is there any Software available for calculating Grade point averages and converting the same into Grades?

Yes,The institute has its own MIS software for calculation of SGPA,CGPA,etc.

19. Will the teacher be required to do the job of calculating SGPAs etc. and convert the same into Grades?

No. The teacher has to give marks obtained out of whatever maximum marks as it is. Rest is all done by the computer.

20. Will there be any Revaluation or Re-Examination System?

No. There will double valuation of answer scripts. There will be a make up Examination after a reasonable preparation time after the End Semester Examination for specific cases mentioned in the Rules and Regulations. In addition to this, there shall be a 'summer term' (compressed term) followed by the End Semester Exam, to save the precious time of students.

21. How fast Syllabi can be and should be changed?

Autonomy allows us the freedom to change the syllabi as often as we need.

22. Will the Degree be awarded on the basis of onlyfinal year performance?

No. The CGPA will reflect the average performance of all the semester taken together.

23. What are Statutory Academic Bodies?

Governing Body, Academic Council, Examination Committee and Board of Studies are the different statutory bodies. The participation of external members in everybody is compulsory. The institute has nominated professors from IIT, NIT, University (the officers of the rank of Pro-vice Chancellor, Deans and Controller of Examinations) and also the reputed industrialist and industry experts on these bodies.

24. Who takes Decisions on Academic matters?

The Governing Body of institute is the top academic body and is responsible for all the academic decisions. Many decisions are also taken at the lower level like Boards of Studies. Decisions taken at the Board of Studies level are to be ratified at the Academic Council and Governing Body.

25. What is the role of Examination committee?

The Examinations Committee is responsible for the smooth conduct of internal, End Semester and make up Examinations. All matters involving the conduct of examinations, spot valuations, tabulations and preparation of Grade Cards etc fall within the duties of the Examination Committee.

26. Is there any mechanism for Grievance Redressal?

The institute has grievance redressal committee, headed by Dean - Student affairs and Dean - IQAC.

27. How many attempts are permitted for obtaining a Degree?

All such matters are defined in Rules & Regulation

28. Who declares the result?

The result declaration process is also defined. After tabulation work wherein the SGPA, CGPA and final Grades are ready, the entire result is reviewed by the Moderation Committee. Any unusual

deviations or gross level discrepancies are deliberated and removed. The entire result is discussed in the Examinations and Result Committee for its approval. The result is then declared on the institute notice boards as well put on the web site and Students Corner. It is eventually sent to the University.

29. Who will keep the Student Academic Records, University or IARE?

It is the responsibility of the Dean, Academics of the Autonomous College to keep and preserve all the records.

30. What is our relationship with the JNT University?

We remain an affiliated college of the JNT University. The University has the right to nominate its members on the academic bodies of the college.

31. Shall we require University approval if we want to start any New Courses?

Yes, It is expected that approvals or such other matters from an autonomous college will receive priority.

32. Shall we get autonomy for PG and Doctoral Programmes also?

Yes, presently our PG programs also enjoying autonomous status.

MALPRACTICES RULES

DISCIPLINARY ACTION FOR / IMPROPER CONDUCT IN EXAMINATIONS

S. No	Nature of Malpractices/Improper conduct	Punishment
	If the candidate:	
1. (a)	Possesses or keeps accessible in examination hall, any paper, note book, programmable calculators, cell phones, pager, palm computers or any other form of material concerned with or related to the subject of the examination (theory or practical) in which he is appearing but has not made use of (material shall include any marks on the body of the candidate which can be used as an aid in the subject of the examination)	Expulsion from the examination hall and cancellation of the performance in that subject only.
(b)	Gives assistance or guidance or receives it from any other candidate orally or by any other body language methods or communicates through cell phones with any candidate or persons in or outside the exam hall in respect of any matter.	Expulsion from the examination hall and cancellation of the performance in that subject only of all the candidates involved. In case of an outsider, he will be handed over to the police and a case is registered against him.
2.	Has copied in the examination hall from any paper, book, programmable calculators, palm computers or any other form of material relevant to the subject of the examination (theory or practical) in which the candidate is appearing.	Expulsion from the examination hall and cancellation of the performance in that subject and all other subjects the candidate has already appeared including practical examinations and project work and shall not be permitted to appear for the remaining examinations of the subjects of that Semester/year. The Hall Ticket of the candidate is to be cancelled and sent to the Controller of Examinations.
3.	Impersonates any other candidate in connection with the examination.	The candidate who has impersonated shall be expelled from examination hall. The candidate is also debarred and forfeits the seat. The performance of the original candidate, who has been impersonated, shall be cancelled in all the subjects of the examination (including practicals and project work) already appeared and shall not be allowed to appear for examinations of the remaining subjects of that semester/year. The candidate is also debarred for two consecutive semesters from class work and all semester end examinations. The continuation of the course by the candidate is subject to the academic regulations in connection with forfeiture of seat. If the imposter is an outsider, he will be handed over to the police and a case is registered against him.

4.	Smuggles in the Answer book or additional sheet or takes out or arranges to send out the question paper during the examination or answer book or additional sheet, during or after the examination.	Expulsion from the examination hall and cancellation of performance in that subject and all the other subjects the candidate has already appeared including practical examinations and project work and shall not be permitted for the remaining examinations of the subjects of that semester/year. The candidate is also debarred for two consecutive semesters from class work and all semester end examinations. The continuation of the course by the candidate is subject to the academic regulations in connection with forfeiture of seat.
5.	Uses objectionable, abusive or offensive language in the answer paper or in letters to the examiners or writes to the examiner requesting him to award pass marks.	Cancellation of the performance in that subject.
6.	Refuses to obey the orders of the Controller of Examinations /Additional Controller of Examinations/any officer on duty or misbehaves or creates disturbance of any kind in and around the examination hall or organizes a walk out or instigates others to walk out, or threatens the COE or any person on duty in or outside the examination hall of any injury to his person or to any of his relations whether by words, either spoken or written or by signs or by visible representation, assaults the COE or any person on duty in or outside the examination hall or any of his relations, or indulges in any other act of misconduct or mischief which result in damage to or destruction of property in the examination hall or any part of the Institute premises or engages in any other act which in the opinion of the officer on duty amounts to use of unfair means or misconduct or has the tendency to disrupt the orderly conduct of the examination.	In case of students of the college, they shall be expelled from examination halls and cancellation of their performance in that subject and all other subjects the candidate(s) has (have) already appeared and shall not be permitted to appear for the remaining examinations of the subjects of that semester/year. The candidates also are debarred and forfeit their seats. In case of outsiders, they will be handed over to the police and a police case is registered against them.
7.	Leaves the exam hall taking away answer script or intentionally tears of the script or any part thereof inside or outside the examination hall.	Expulsion from the examination hall and cancellation of performance in that subject and all the other subjects the candidate has already appeared including practical examinations and project work and shall not be permitted for the remaining examinations of the subjects of that semester/year. The candidate is also debarred for two consecutive semesters from class work and all semester end examinations. The continuation of the course by the candidate is subject to the academic regulations in connection with forfeiture of seat.
8.	Possess any lethal weapon or firearm in the examination hall.	Expulsion from the examination hall and cancellation of the performance in that subject and all other subjects the candidate has already appeared including practical examinations and

		project work and shall not be permitted for the remaining examinations of the subjects of that semester/year. The candidate is also debarred and forfeits the seat.
9.	If student of the college, who is not a candidate for the particular examination or any person not connected with the college indulges in any malpractice or improper conduct mentioned in clause 6 to 8.	Student of the colleges expulsion from the examination hall and cancellation of the performance in that subject and all other subjects the candidate has already appeared including practical examinations and project work and shall not be permitted for the remaining examinations of the subjects of that semester/year. The candidate is also debarred and forfeits the seat. Person(s) who do not belong to the College will be handed over to police and, a police case will be registered against them.
10.	Comes in a drunken condition to the examination hall.	Expulsion from the examination hall and cancellation of the performance in that subject and all other subjects the candidate has already appeared including practical examinations and project work and shall not be permitted for the remaining examinations of the subjects of that semester/year.
11.	Copying detected on the basis of internal evidence, such as, during valuation or during special scrutiny.	Cancellation of the performance in that subject and all other subjects the candidate has appeared including practical examinations and project work of that semester/year examinations.
12.	If any malpractice is detected which is not covered in the above clauses 1 to 11 shall be reported to the University for further action to award suitable punishment.	

INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)
Dundigal, Hyderabad - 500 043

UNDERTAKING BY STUDENT/PARENT

"To make the students attend the classes regularly from the first day of starting of classes and be aware of the College regulations, the following Undertaking Form is introduced which should be signed by both student and parent. The same should be submitted to the Dean, Academic".

I, Mr./Ms ---------- joining I Semester for the academic year 2018-2019 in Institute of Aeronautical Engineering, Hyderabad, do hereby undertake and abide by the following terms, and I will bring the ACKNOWLEDGEMENT duly signed by me and my parent and submit it to the Dean, Academic.

1. I will attend all the classes as per the timetable from the starting day of the semester specified in the institute Academic Calendar. In case, I do not turn up even after two weeks of starting of classes, I shall be ineligible to continue for the current academic year.
2. I will be regular and punctual to all the classes (theory/practical/drawing) and secure attendance of not less than 80% in every course as stipulated by Institute. I am fully aware that an attendance of less than 70% in more than three courses will make me lose one year.
3. I will compulsorily follow the dress code prescribed by the college.
4. I will conduct myself in a highly disciplined and decent manner both inside the classroom and on campus, failing which suitable action may be taken against me as per the rules and regulations of the institute.
5. I will concentrate on my studies without wasting time in the Campus/Hostel/Residence and attend all the tests to secure more than the minimum prescribed Class/Sessional Marks in each course. I will submit the assignments given in time to improve my performance.
6. I will not use Mobile Phone in the institute premises and also, I will not involve in any form of ragging inside or outside the campus. I am fully aware that using mobile phone to the institute premises is not permissible and involving in Ragging is an offence and punishable as per JNTUH/UGC rules and the law.
7. I declare that I shall not indulge in ragging, eve-teasing, smoking, consuming alcohol drug abuse or any other anti-social activity in the college premises, hostel, on educational tours, industrial visits or elsewhere.
8. I will pay tuition fees, examination fees and any other dues within the stipulated time as required by the Institution / authorities, failing which I will not be permitted to attend the classes.
9. I will not cause or involve in any sort of violence or disturbance both within and outside the college campus.
10. If I absent myself continuously for 3 days, my parents will have to meet the HOD concerned/ Principal.
11. I hereby acknowledge that I have received a copy of IARE - R18 Academic Rules and Regulations, Syllabus copy and hence, I shall abide by all the rules specified in it.

ACKNOWLEDGEMENT

I have carefully gone through the terms of the undertaking mentioned above and I understand that following these are for my/his/her own benefit and improvement. I also understand that if I/he/she fail to comply with these terms, shall be liable for suitable action as per Institute/JNTUH/AICTE/UGC rules and the law. I undertake that I/he/she will strictly follow the above terms.

Signature of Student with Date

Signature of Parent with Date
Name & Address with Phone Number